

REPORT FOR
ENERGY MINES AND RESOURCES CANADA

DEVELOPMENT AND DEMONSTRATION OF CALIBRATED MODELLING
AS A TECHNIQUE TO EVALUATE THE PERFORMANCE AND
COST EFFECTIVENESS OF PASSIVE SOLAR OFFICE BUILDING SYSTEMS

DSS CONTRACT SERIAL NO.: 23216-6-6258/01-SZ

FILE: 6175,DD#60

Prepared by:

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T2-W3
86-6258

SEPTEMBER 30, 1987



G.K. Yuill & Associates Ltd.
Consulting Engineers

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FILE: 6175,DD#60

89-06354/

SEPTEMBER 30, 1987

Tim Mayo
Passive Solar Energy Coordinator
ENERGY, MINES AND RESOURCES CANADA
Renewable Energy Branch
400 O'Connor Street, 4th Floor
OTTAWA, Ontario
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RE: Thermal Performance Modelling Using a Calibrated Model
DSS File No.: 48SZ 23216-6-6258

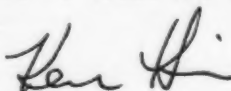
Dear Mr. Mayo:

Enclosed are five copies of the revised report for the Thermal Performance Modelling Using a Calibrated Model, DSS File No.: 48SZ 23216-6-6258.

I hope that the revisions I have made will meet with your satisfaction.

Sincerely,

G. K. YUILL AND ASSOCIATES LTD.



Kane Gin, B.Sc.(M.E.)

KG:al

Encl.

cc: Michel Rancourt

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ABSTRACT

The development and demonstration of a technique to evaluate the performance of passive solar office buildings by calibrated modelling was completed in this project. This project is the continuation of a previous project under contract with NRC/SEP (DSS File Number 04SR.31025-4-3047, Contract Serial Number 05R84-00137). The previous report described the monitoring of a low-rise passive solar office building, and the initial development of a BLAST computer model of the building.

The BLAST model was refined in this project so that it provided thermal performances similar to that of the monitored data. The model was run for a year of data in its original configuration and in a configuration with some of the passive solar elements removed. The contribution to the building space heating from the passive solar elements was found, and an economic analysis performed to evaluate the benefit of these elements.

Calibrated modelling can provide a technique to develop a building model with accuracy that is difficult to attain with any other technique. This technique also requires a substantial amount of effort to complete, and may be more suitable as a research tool than a design aid.

1.0 INTRODUCTION

The project reported here is a continuation of a project recently carried out by G. K. Yuill and Associates Ltd., to develop and demonstrate the "calibrated modelling" technique for evaluating the contribution of passive solar energy to the heating of office buildings.

It has long been realized by the building industry that passive solar systems can be an effective means of reducing the heating energy requirement of buildings in cold climates. However, the actual performance of a passive solar system cannot be easily evaluated. With active solar systems, it is usually possible to establish performance by directly measuring the energy output of the system. Passive solar systems, on the other hand, are almost always integrated into the construction of the building, which makes direct measurement of their performance extremely difficult. Such systems can sometimes be directly monitored with extensive instrumentation, and a great deal of effort. Usually the building must also be unoccupied for such direct monitoring, which in the case of a commercial office building, may not be possible. Also, evaluation of the passive solar features of an unoccupied building would not be representative of the actual performance of the system because of the elimination of internal gains (from people, lights and appliances) which can have a significant effect on the utilization of solar energy gains. Therefore, alternative methods of evaluating the performance of passive solar systems are required.

In 1982, the National Research Council/Solar Energy Program (NRC/SEP) established a Level B performance evaluation program in order to quantify the thermal contribution of passive solar elements in homes. The Level B monitoring methodology was founded on work done at the Solar Energy Research Institute (SERI) in Colorado. In addition, fundamental testing procedures developed or adapted for Canadian use at the NRC Division of Building Research (NRC/DBR) were utilized in this class of building monitoring. NRC/SEP continued to refine and develop the Level B procedure by the monitoring of residential and commercial buildings across Canada. This work was done under contract with NRC/SEP by

several contractors based near the locations of the buildings being monitored. G. K. Yuill and Associates Ltd. was engaged in the performance monitoring of the Smith Carter Partners (SCP) Head Office building located in Winnipeg, Manitoba. This work was done under contract with NRC/SEP (DSS File Number 04SR.31025-4-3047, Contract Serial Number 05R84-00137), and was part of the 1984-85 monitoring program. Specific objectives of the 1984-85 program were:

- (i) the Level B monitoring of prototypical passive solar buildings including direct gain systems for low and medium/high-rise residential buildings, attached sunspace systems, and integrated passive systems for low-rise commercial and residential buildings;
- (ii) evaluation and improvement of the performance evaluation techniques and the standard performance testing and monitoring procedures outlined in the "Level B Monitoring Manual for Performance Evaluation of Passive Solar Homes";
- (iii) development and testing of new monitoring techniques and procedures specifically for the evaluation of passive solar systems in commercial buildings.

The Smith Carter Partners Office building performance evaluation project concentrated largely on Objective (iii) above. The approach was to accurately determine the solar radiation utilized in this low-rise passive solar office building by using a calibrated modelling approach. In this method, a detailed BLAST computer model of the building was developed. The Building Loads and System Thermodynamics (BLAST) program is a sophisticated computer analysis tool which does an hour-by-hour heat balance on a building in order to calculate heating and/or cooling loads. The initial BLAST model of the building was to be refined or calibrated to improve the agreement between BLAST-predicted and observed thermal parameters. The observed performance data was collected using a microprocessor-based data acquisition system capable of monitoring up to 22 sensors measuring relevant thermal parameters. Once an accurate BLAST model of the building was obtained, it was to be

used to determine the amount by which internal utilization of incoming solar radiation offsets the auxiliary heating energy requirement of the building. This was to be done by comparing BLAST simulations of the heating energy required by the building over some time period in the actual climate with that which would be required in an identical hypothetical climate in which there is no solar radiation. Several difficulties were encountered in carrying out this work. The major ones were caused by the nature of the building heating, ventilating and air conditioning (HVAC) system and by the data logging equipment provided by NRC. The HVAC system is very innovative and unusual and proved particularly hard to simulate using the library of models of conventional equipment available in BLAST. The data logging equipment, which is somewhat out of date, broke down repeatedly, causing the loss of data and adding to the monitoring costs.

As a result of these difficulties, it became apparent that the original budget would be exhausted before the project was completed. However, the closing of the Solar Energy Program at NRC in 1985 made additional funding from that source impossible. Yuill and Associates were instructed simply to report the data that had been collected and not to attempt to finish the project.

The present project carried the work which was begun in that previous project to completion. In it, data collected and models developed in the NRC/SEP project were used to further develop and demonstrate the use of the calibrated modelling technique to evaluate the thermal performance of passive solar systems. Use of the method in determining the cost effectiveness of such systems was also demonstrated.

The BLAST model of a building is a detailed description which includes dimensions and orientations of walls, ceilings, floors, and windows, material and building component descriptions, lighting, people, and equipment schedules, and heating/cooling system control profiles. The need to calibrate or refine the original BLAST computer model of the building arises out of a principal objective of the Level B monitoring

program and many other monitoring programs. That objective is to provide accurate and useful results at a reasonable cost. To do detailed continuous monitoring of every single parameter describing the performance of a building, especially a commercial building, would be prohibitively expensive. Therefore, only parameters which are of significance in a building's thermal performance are monitored. Also, to obtain a precisely accurate description of a building's construction would be extremely expensive. A primary requirement would be measurement of the thermal properties of all of the different material components which make up the building. In calibrated modelling the building's initial description is based on material specifications. Material properties in which there is a relatively large amount of uncertainty are adjusted based on discrepancies between the BLAST prediction of building performance and observed performance. It is possible that two or more errors in the building description may have cancelling effects on the predicted performance parameters thereby indicating that the computer model of the building is correct. However, the likelihood of this decreases as the number of parameters being compared increases. It is important to realize that as the number of parameters being compared increases, so does the cost of the monitoring program. Thus, the objective becomes to achieve accurate results at a reasonable cost.

2.0 COMPLETION OF THE CALIBRATED MODEL PROJECT

This project was divided into three tasks - the completion of the calibrated model, the determination of the solar contribution to heating, and the economic analysis of the projected benefit from the solar contribution.

2.1 Model Completion

It is difficult to develop a precise computer model of the thermal performance of a building. The difficulty lies not with the accuracy of the modelling program, but with the accuracy of the physical data describing the building which is used by the computer program.

In the present project, the input data supplied to the program was to be improved until the model performed well enough to be used for predicting the contribution of passive solar energy to the building's heating requirements. This was done by repeatedly running the BLAST program and examining the variations between predicted energy consumption and temperature data and that measured in the building. The forms of the deviations were studied to provide clues as to the sources of the errors. Sometimes these errors could be eliminated by measuring a building property, such as the supply-air temperature to a zone, which had only been guessed previously. In most other cases, it was impossible to measure the doubtful variable, but it was obvious that only an error in the value of this variable could produce the deviation in question. Therefore the variable would be arbitrarily adjusted (within the range of the values which it could realistically have), to eliminate the deviation. Variables which were adjusted include the outside wall R-values, building heating schedules, and the optical properties of the insulated glass fiber panel glazings.

The BLAST analysis consisted of four sets of runs. The first set of runs was the model at the conclusion of the previous project, and it was considered the baseline for which calibration could be done. The next three sets comprised improvements that had been made to the model

to improve the model's performance. Several minor runs were made to determine the model's sensitivity to altering the optical properties of the insulated glass fiber panelling. More information on these minor runs can be found later in this section.

The first set of BLAST runs was a preliminary run, completed at the conclusion of the previous project. It was incomplete in that infiltration and occupancy schedules had not yet been included. These schedules, along with a small number of minor changes, were added to the model for the second run. One schedule in particular that was altered concerned the building occupancy for December 24th. In first trial, it was assumed that this date was a holiday, with no occupancy or equipment use. In actuality, it was a working day until noon, after which the staff held an office party. The new scheduling can be noted in the graphs representing internal electrical usage for trials one and two for December 24 (Figure 4.1.1, and 4.1.2). Since the first run was preliminary, central atrium and south corridor temperatures were not recorded, but only the auxiliary heat required and the internal electrical consumption were compared.

A large number of minor changes were made to the model for the third set of runs. The wall R-value in the upstairs outside walls was decreased from RSI 2.4 to RSI 1.76 to account for the effect of steel studs, which was not considered previously. In a similar manner, the wall R-value in the downstairs walls was reduced from RSI 3.52 to RSI 3.25 to account for the effect of the wood strapping. The new R-values in both the upper and lower walls were estimated by determining the value required to maintain the monitored temperature.

The peak infiltration in most of the zones was increased. The schedule for infiltration in the vestibules was also slightly modified to increase night infiltration slightly.

The heating capacities of most of the zones were changed. The supply air entering each of the zones was supposed to have a design temperature of 32°C. Many of the zones had measured supply-air

temperatures below 32°C, so their heating capacities were reduced accordingly.

The final set of runs had a large number of small changes as well. The index of refraction of the insulated glass fiber panels was increased from 1.52 to 1.57, to decrease solar gains during off-angle incidences. The controls for all of the zones had their temperature settings increased by one degree, i.e., the heating setpoint, zero point, and cooling setpoint increased by one degree. This was done to increase the mean temperature of each of the zones, and is likely a better approximation to the real behavior of the control system considering the unique control strategy of the building. This control strategy was described in much greater detail in the previous report (1).

The heating capacities were increased again in some of the zones, most notably Zone 3, the central atrium. This was done because there was some uncertainty as to the supply-air flows into each zone.

The monitored internal electrical consumption had included the energy used for exterior lighting and outdoor car block heaters and interior car warmers, as there was no way to determine this value separately. The fourth run included an estimate of the outdoor consumption; 5 kW exterior lighting continuously, and an automotive electrical usage of 30 kW from 9 a.m. to 3 p.m. weekdays, and 20 kW from 12 p.m. to 6 p.m. on weekends. No attempt was made to relate ambient temperature to automotive electrical usage, as block heaters tend to be used in winter regardless of temperature.

Several shorter term runs were made to determine the model sensitivity to the optical properties of the insulated glass fiber panelling. The baseline was set at a nominal transmissivity of 0.32 and an index of refraction of 1.57. The nominal transmissivities were set to either 0.25 or 0.29 with an index of refraction of 1.52. One run was made with a nominal transmissivity of 0.32 and an index of refraction of 1.62. The zone temperatures of the south corridor and

central atrium were then compared, and it was found that there was an insignificant difference in the temperatures in these zones as a function of the optical properties of the insulated glass fiber panels.

The figures show the result of the major trials. In Figures 1.1.1 to 1.1.4, the auxiliary heating energy for the four BLAST runs are plotted against the measured data for December 21 to 26, 1985, the primary period which was chosen for the optimization of the building description. This period and the January 3 to January 8, 1986 period were chosen because they were periods of contiguous data with a range of solar intensities and building occupancy levels. The December time periods included weekends, and a holiday. The January time period was only used for the third and fourth runs to attempt to gain more insights into the model as it attained greater accuracy. It can be seen that a great improvement has been made in the accuracy of the simulation from the first to the third attempt. Figures 2.1.1 to 2.1.3 show the predictions of the south corridor temperature for the second, third and fourth simulations for the December 21 - 26 time period. Figures 2.21 and 2.22 show the south corridor temperature for January 3 - 8. These predictions are particularly important since the south corridor is one of the main areas where solar radiation enters the building, and is one of the two areas in the building which contain insulated glass fiber panelling.

The temperature for the central atrium is shown in Figures 3.1.1 through 3.2.2. This area is also of importance because of the large area of insulated glass fiber panelling which makes up the skylight. It can be seen that the atrium temperature showed significant improvement with each trial.

The last parameter, the building electrical consumption, is shown in Figures 4.1.1 through 4.2.2. The fourth trials are the most important since they include models of the exterior electrical consumption, which were not included in the previous trials.

If the building description has been correctly adjusted, the BLAST predictions of energy consumption and temperature should be close to the measured values not only for the period which was used to make the adjustment but for other periods as well. Figures 1.2.2 and 4.2.2 show that this is the case for auxiliary heating and electrical consumption for the building description used to produce Figures 2.2.2 and 3.3.2. The BLAST predictions are as good for the period January 3 to January 8, 1986 as for the previous period. Much of the remaining deviation can be explained by human behavior in the building. For example, BLAST assumes the same lighting schedule for every weekday, while some of the overheating predicted but not measured corresponded to lower than expected electricity use measured in the building. Also, the very low temperatures measured but not predicted in the south corridor were probably due to manual setback of the local thermostats overnight.

In its final form, the BLAST model of the building predicted the performance of the actual building with reasonable accuracy. The BLAST input file for the measured data runs can be found in the Appendix. This model was then used to predict the contribution of passive solar gains to reduce auxiliary heating on this building.

2.2 Evaluation of Passive Solar Elements

To assess the effectiveness of the passive solar elements in the SCP building, the BLAST model was used for two simulations, each using a year of measured weather data. Weather data for Winnipeg in 1978, measured at Winnipeg International Airport, was used since the monthly average dry-bulb temperature conformed closely to long-term average temperature data from Environment Canada.

The initial simulation was made with the BLAST model essentially unchanged from the previous runs. The most significant change was the addition of large heating and cooling capabilities to determine zone heating and cooling loads. Normally when a building is modelled with BLAST, the zone loads are found, and the air-handling and central plant systems are modelled to find the total energy consumption of the

building. The impossibility of modelling the innovative air-handling system used in the building with the techniques available in BLAST made it necessary to make comparisons of the heating loads imposed on the air-handling system rather than on the ultimate energy use of the central plant. Using large heating and cooling capacities allows a more accurate estimation of the zone loads. The west, east and entrance vestibules were modelled without cooling. As well, the crawl space beneath the drafting area, and the mechanical and electrical rooms were modelled without heating or cooling.

It was initially proposed that the building would be modelled both in the presence and absence of solar radiation, to determine the solar contribution to heating. It was realized that a more meaningful approach was to model alternate building configurations with realistic solar radiation data. For any building, passive solar or otherwise, passive solar gains are realized by absorption of solar radiation on the opaque outer walls and to a lesser extent by the absorption on the clear glazings. This additional heat input has a significant effect on the space conditioning energy required. However, these passive solar gains are realized by every building, not necessarily those which are designed with passive solar benefits in mind. A better means to determine the passive solar benefits of specific buildings would be to model passive solar buildings both with and without identifiable passive solar elements. Differences in space conditioning energy can then be found between the differing building configurations.

Two simulations were made. The first simulation consisted of the Smith Carter Partners buildings as it exists presently. The second simulation was done using identical weather data, but with a modified building. The insulated glass fiber panels in the south corridor and central atrium were replaced with wall or roof sections similar to surrounding areas. This was done because these panels could be considered the identifiable passive solar feature of the building. It should be noted that for the atrium panelling, passive solar benefits were of secondary concern to the designer compared to the architectural and aesthetic benefits in this building. Economic benefits are not

expected from this system, but its effectiveness as a passive solar device can still be evaluated.

2.3 Economic Analysis

Cost savings were calculated only for heating. As was stated in the previous report, although the heat pump can act as a chiller, cooling energy is always totally supplied from the well water passing directly over the system cooling coils. Because of this, the only energy associated with cooling would be the energy used in the VAV air-handling system.

Because of the difficulties in modelling the VAV air-handling system, which were outlined in the previous report (1), the heating system savings estimate was made considering only the heat pump without taking into account the reduction of fan power in the air-handling system. Because the system efficiency would certainly be lower with an air-handling system in place, the savings would be conservative. The heat pump COP was calculated to be 3.0 at full-load conditions.

Table 1 shows the results of the BLAST simulations. The total monthly heating loads for each of the zones are shown for the cases with and without insulated glass fiber panelling. Table 2 shows a summary of the BLAST zones. The total energy savings for the zones that would be serviced by the central plant (i.e. Zones 1,3,5-13, all the zones except the vestibules) was about 800 kWh/yr. The vestibules, which are electrically heated, show a net increase in energy usage in the order of 20 kWh/yr. This increase is insignificant and is likely simply an artifact of several interrelations between glazing orientation, infiltration and air mixing from other zones.

If the full load heat pump COP is 3.0, then the electrical energy required for auxiliary heating would be

$$\begin{aligned} ES_{\text{ann}} &= (800/3.0) \text{ kWh/yr} + (-20) \text{ kWh} \\ &\approx 250.0 \text{ kWh/yr.} \end{aligned}$$

Total Monthly Zone Heating Loads (tKWh) SCP Building w/ Kalwall

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Total
Jan	21210.00	824.20	6514.00	903.30	1440.00	2400.00	2338.00	3152.00	3799.00	0.00	0.00	3397.00	129.10	791.49	46898.00
Feb	16590.00	543.10	4597.00	647.60	1127.00	1786.00	1775.00	2491.00	2615.00	0.00	0.00	2794.00	130.20	531.80	35617.70
Mar	12480.00	257.90	3153.00	374.30	881.00	1169.00	1328.00	1938.00	1921.00	0.00	0.00	2399.00	144.90	342.60	26388.70
Apr	6689.00	72.19	1485.00	79.55	509.30	443.20	704.10	1055.00	1030.00	0.00	0.00	1648.00	126.90	128.00	13890.24
May	2449.00	1.99	428.90	1.28	136.40	55.97	243.90	264.20	390.10	0.00	0.00	1030.00	96.51	27.84	5266.08
Jun	1696.00	0.34	265.30	0.20	139.60	32.03	162.10	258.10	268.10	0.00	0.00	845.20	62.98	10.48	3740.43
Jul	1103.00	0.00	106.50	0.00	88.98	4.17	92.35	149.80	147.50	0.00	0.00	714.20	38.22	0.02	2445.34
Aug	1539.00	0.00	240.00	0.00	110.20	12.91	135.70	211.50	228.80	0.00	0.00	710.10	19.44	5.62	3223.27
Sep	2743.00	4.02	559.20	7.91	187.70	46.62	251.00	373.30	414.10	0.00	0.00	867.00	19.37	29.06	5502.27
Oct	6117.00	87.45	1566.00	105.90	432.30	293.60	636.10	897.90	1080.00	0.00	0.00	1348.00	35.94	129.90	12729.99
Nov	13130.00	450.00	4026.00	498.10	870.90	1239.00	1482.00	1955.00	2568.00	0.00	0.00	2165.00	61.03	487.40	28932.43
Dec	19390.00	722.10	5929.00	790.10	1337.00	2118.00	2103.00	2856.00	3427.00	0.00	0.00	3103.00	101.70	625.80	42502.70
Ann	105056.00	2963.18	28869.90	3408.34	7310.28	9600.50	11251.25	15701.80	17878.60	0.00	0.00	21021.10	966.29	3109.92	227137.16

Total Monthly Zone Heating Loads (tKWh) SCP Building w/o Kalwall

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Total
Jan	21200.00	822.30	5774.00	902.30	1439.00	2398.00	2334.00	3138.00	3929.00	0.00	0.00	3395.00	129.00	787.70	46248.30
Feb	16580.00	541.40	4667.00	646.80	1126.00	1783.00	1772.00	2485.00	2991.00	0.00	0.00	2790.00	130.10	529.50	36041.80
Mar	12500.00	257.20	3647.00	373.20	880.40	1167.00	1326.00	1935.00	2246.00	0.00	0.00	2397.00	145.00	340.20	27214.00
Apr	6644.00	72.30	1897.00	79.57	509.90	443.80	704.80	1056.00	1202.00	0.00	0.00	1649.00	127.20	127.80	14513.37
May	2492.00	1.90	578.90	1.33	187.20	56.12	244.50	365.10	446.60	0.00	0.00	1031.00	96.60	27.87	5529.12
Jun	1732.00	0.34	386.50	0.20	140.00	32.18	162.70	259.20	324.30	0.00	0.00	846.20	63.08	10.48	3957.18
Jul	1135.00	0.00	165.00	0.00	89.41	4.18	92.81	150.20	200.10	0.00	0.00	715.60	38.25	0.02	2590.57
Aug	1537.00	0.00	270.90	0.00	110.70	12.96	136.20	211.90	270.90	0.00	0.00	711.00	19.51	5.61	3326.68
Sep	2765.00	4.05	560.50	7.89	188.00	46.66	251.40	372.90	447.20	0.00	0.00	867.30	19.43	28.87	5559.20
Oct	6128.00	87.12	1501.00	105.50	432.30	293.60	636.00	898.90	1102.00	0.00	0.00	1348.00	35.91	129.50	12697.83
Nov	13130.00	448.80	3535.00	497.50	870.50	1238.00	1481.00	1953.00	2496.00	0.00	0.00	2164.00	61.04	485.90	28366.74
Dec	19390.00	720.60	5193.00	789.30	1337.00	2116.00	2102.00	2854.00	3560.00	0.00	0.00	3102.00	101.70	624.10	41889.70
Ann	105273.00	2956.00	28175.80	3403.60	7310.41	9591.50	11243.41	15679.20	19215.10	0.00	0.00	21016.10	966.82	3097.55	227928.49

Table 1

Zone Number	Zone Title	System Providing Heating
1	DRAFTING ROOM	Central HVAC System
2	WEST VESTIBULE	4 kW Forced Flow Electric Heater
3	KALWALL-ROOF TWO-STORY ATRIUM	Central HVAC System
4	EAST VESTIBULE	4 kW Forced Flow Electric Heater
5	ACCOUNTING OFFICES	Central HVAC System
6	COMPUTER, SECRETARY AND MEETING ROOMS	Central HVAC System
7	RECEPTION AREA	Central HVAC System
8	CONFERENCE ROOM	Central HVAC System
9	SUNLIT CORRIDOR AND PARTNERS OFFICES	Central HVAC System
10	CRAWL SPACE	Return Air Flow
11	ELECTRICAL AND MECHANICAL ROOMS	Return Air Flow
12	BASEMENT PERIMETER ROOMS	Central HVAC System
13	BASEMENT CENTRE	Central HVAC System
14	FRONT VESTIBULE	6 kW Forced Flow Electric Heater

Table 2. Summary of BLAST Zones

where ES_{ann} = electrical energy savings, kWh/yr.

The vestibule heaters were assumed to be radiant heaters, operating at 100% efficiency. Assuming that the heating system is on an uninterruptible service schedule, the cost of the electrical savings based on electrical consumption for a medium-density service area after the first 185 kWh is \$0.03653 per kWh. The net annual benefit from the addition of insulated glass fiber panelling would be

$$\begin{aligned} CS_{ann} &= 250.0 \text{ kWh/yr} * \$0.03653/\text{kWh} \\ &\approx \$9.00/\text{yr} \end{aligned}$$

where CS_{ann} = annual cost savings from addition of insulated glass fiber panelling, \$/yr.

The additional cost of installing the insulated glass fiber panelling over installing wall and ceiling construction similar to surrounding areas was estimated to be \$6,863.79 by Smith Carter Partners. The payback period, assuming an annual energy cost inflation rate of 4% would be approximately 90 years. Although the economic benefits from the insulated glass fiber panelling are not very large, it is understandable since the expected economic benefits were not given as much priority as the aesthetic benefits and the desire to maximize natural lighting in the building.

3.0 DISCUSSION

The process of generating a calibrated model for a building involves continuously monitoring several performance parameters that affect building energy consumption. A building model is then produced using a building energy analysis computer program. The model is then improved, or calibrated, until the energy usage compares favorably with the monitored data. The resulting model can then be used to evaluate the building performance if passive solar or other methods are implemented.

Although the process appears simple, in practice a substantial amount of effort is required to complete the monitoring and modelling portions. To ensure that an adequate model is developed, a large number of parameters must be monitored, such as building-zone temperatures, energy usage, and local solar radiation and temperature data. This information must be gathered over a significant period of time, at least a few weeks. The monitoring process requires regular and frequent attention to ensure that the monitoring equipment provides meaningful results. Some parameters, such as interzone air flows, can be measured by a technique such as sulphur hexafluoride tracer gas testing, but this will be time consuming.

A large amount of effort is also required to calibrate the model so that its performance matches that of the monitored data. As an example, when the building is modelled, a zone might have a temperature that is higher than the monitored temperature. Several measures might be taken to reduce the temperature: reducing the wall R-value, the heating capacity, the interzone airflows or any number of other parameters. Often a change in one variable will cause changes in other parameters. A change in heating capacity may cause the zone temperature to be correctly predicted, but adversely affect the auxiliary heating requirement. Sometimes the variable that must be changed is evident, but more often both judgement and experimentation are required to achieve good agreement.

The sophistication of the building energy analysis program used also has a bearing on the effort required to complete the calibration of the model. The program that was used in this project, the BLAST simulation, is a well-verified and complex model that can emulate the performance of several different types of air handling and central plant systems. However, the heating and cooling system used in the SCP building was innovative in many ways, and did not allow a straightforward modelling with BLAST or any other similar program. A significant amount of time was used unsuccessfully in attempting to use the existing BLAST facilities to simulate the characteristics of the building heating system. Further details on this matter can be found in the previous report (1).

Several of the building properties could only be guessed or estimated, increasing the amount of time required to complete the calibration of the model. Examples include the fiberglass insulation in the outer walls of the building and the insulated glass fiber panelling of the south corridor and central atrium. The fiberglass insulation thickness was specified in the building specification, but for a given thickness of the fiberglass insulation, a range of insulation values were available, and some experimentation was required to find the level that was used. Similarly, optical properties of the insulated glass fiber panelling such as the index of refraction could not be found, and were estimated.

The potential for very accurately modelling existing buildings is present with the calibrated model technique, though a good deal of effort is required.

4.0 CONCLUSIONS

The results obtained in this project show that, while the calibrated modelling technique has the potential of producing a very accurate model of a building, it has two disadvantages. One is that it requires a large amount of expense and effort. The other is that it can only be applied to buildings which are conventional enough in design and operation to be modelled by the computer program to be used.

The former difficulty leads to the conclusion that the calibrated modelling technique is best suited to be used as a research tool to determine parameters of building thermal operation which can't be conveniently determined by any other means. The latter difficulty suggests that the nature of the building, especially of its heating, ventilating and air conditioning system, should be carefully reviewed before beginning a calibrated modelling project. That was not done in the present case because this was the first building we had ever encountered whose mechanical equipment could not be modelled by BLAST.

A secondary object of the present project was to assess the passive solar gains resulting from the use of insulated glass fiber panels on the Smith Carter Partners Building. It was found that the saving in heating energy was approximately 250.0 kWh per year, with a value of about \$9.00. Thus the payback period on the cost of the panels would then be approximately 90 years. Obviously, these panels could not be justified on the basis of energy saving alone, but only if they contributed to natural lighting or building aesthetics.

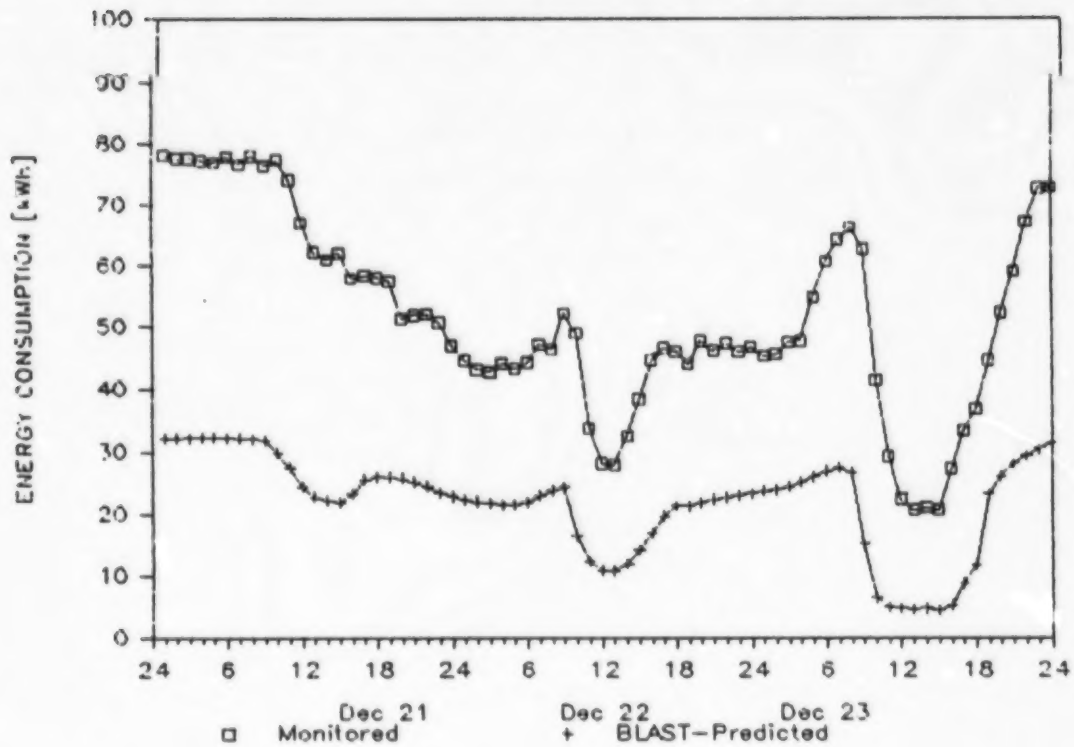
Because of the difficulties encountered in modelling the Smith Carter Partners building, it is felt that for many applications, the calibrated model technique would require an excessive amount of effort to be truly useful. These difficulties make the preparation of a set of generalized guidelines for the calibrated model technique of limited utility. Therefore, such a set of guidelines has not been included.

REFERENCES

1. G. K. Yuill and Associates Ltd., "Performance Monitoring of the Smith Carter Partners office Building", report for the National Research Council Solar Energy Program, July 1986.

FIGURES

AUXILIARY HEATING ENERGY



AUXILIARY HEATING ENERGY

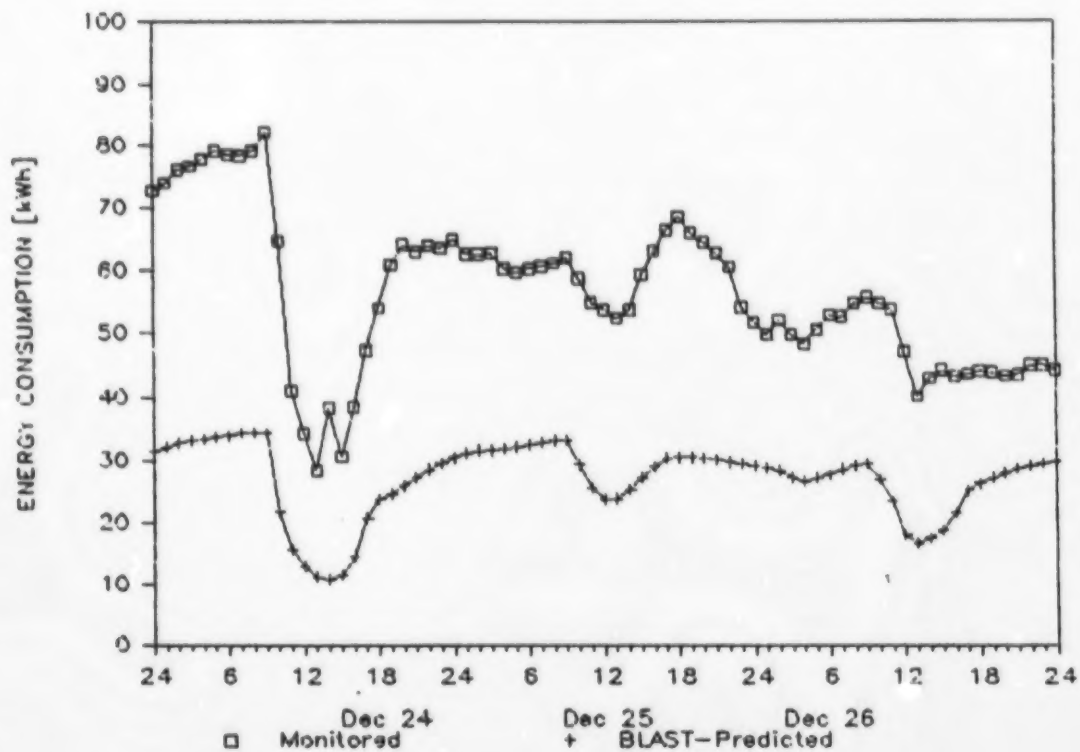
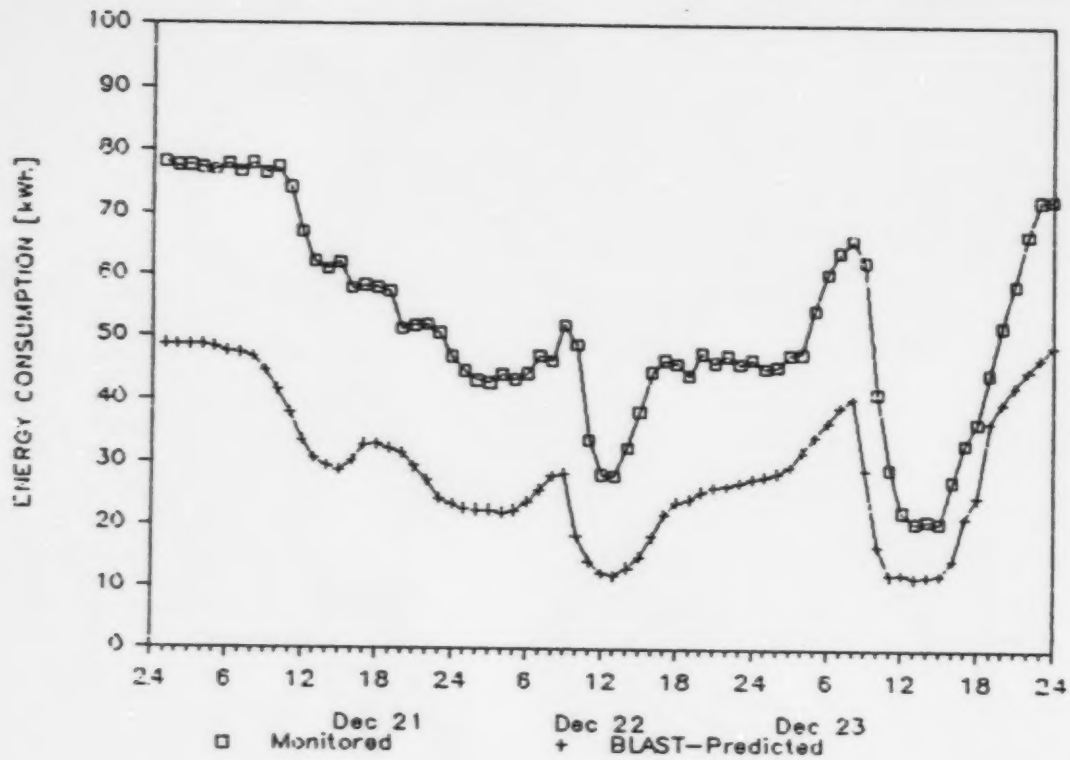


Figure 1.1.1 Auxiliary Heating Energy
December 21 - 26

AUXILIARY HEATING ENERGY



AUXILIARY HEATING ENERGY

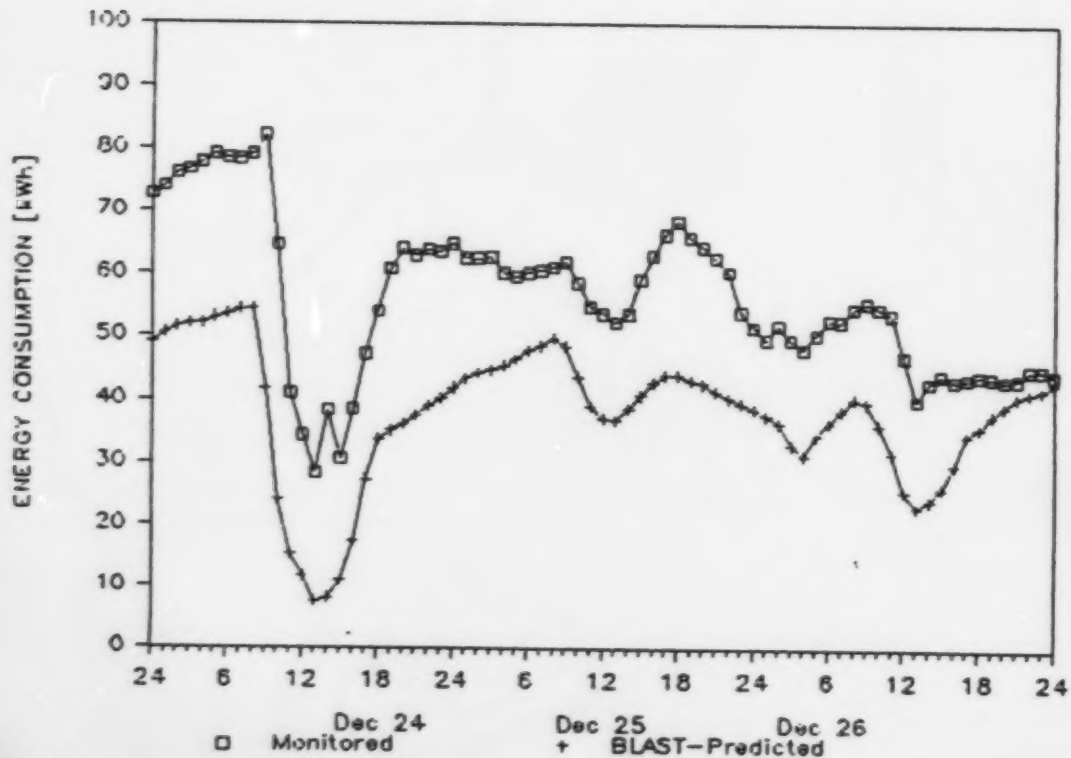
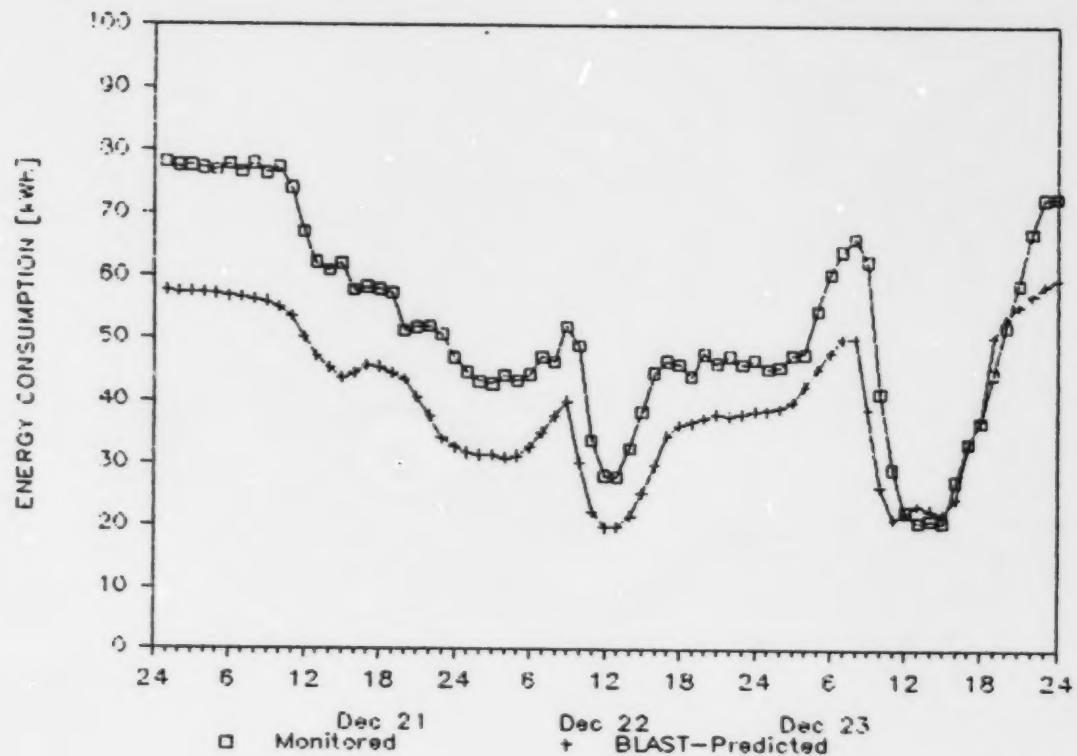


Figure 1.1.2 Auxiliary Heating Energy
December 21 - 26
Trial 2

AUXILIARY HEATING ENERGY



AUXILIARY HEATING ENERGY

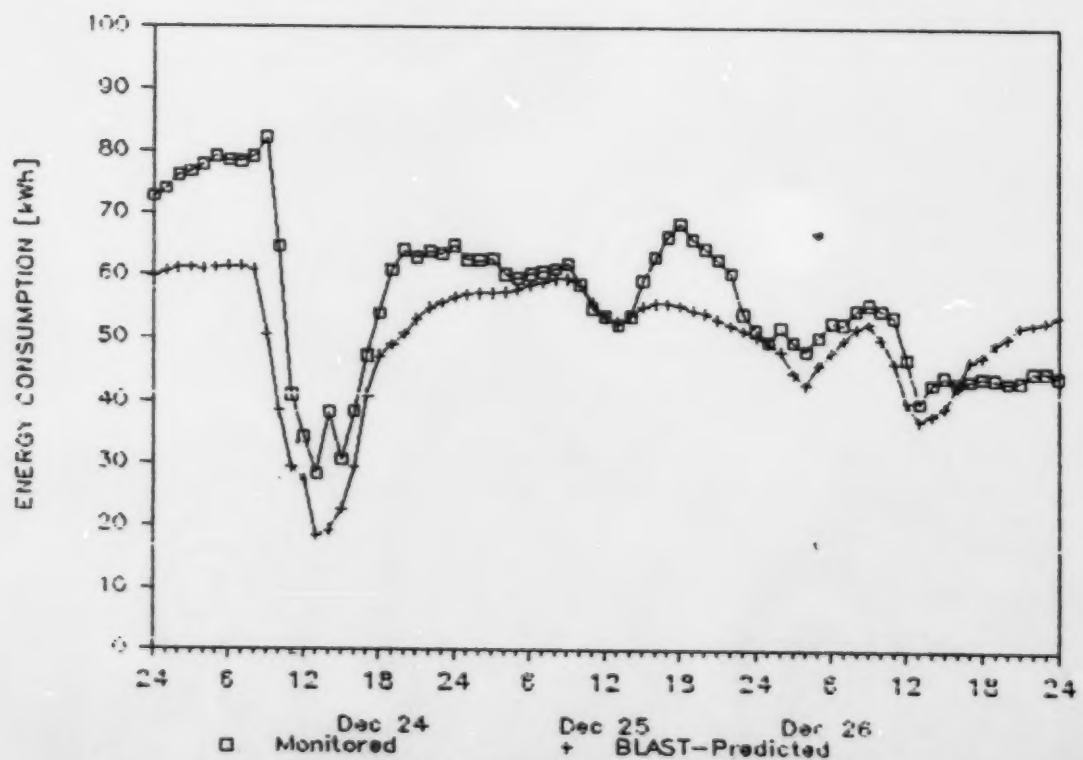
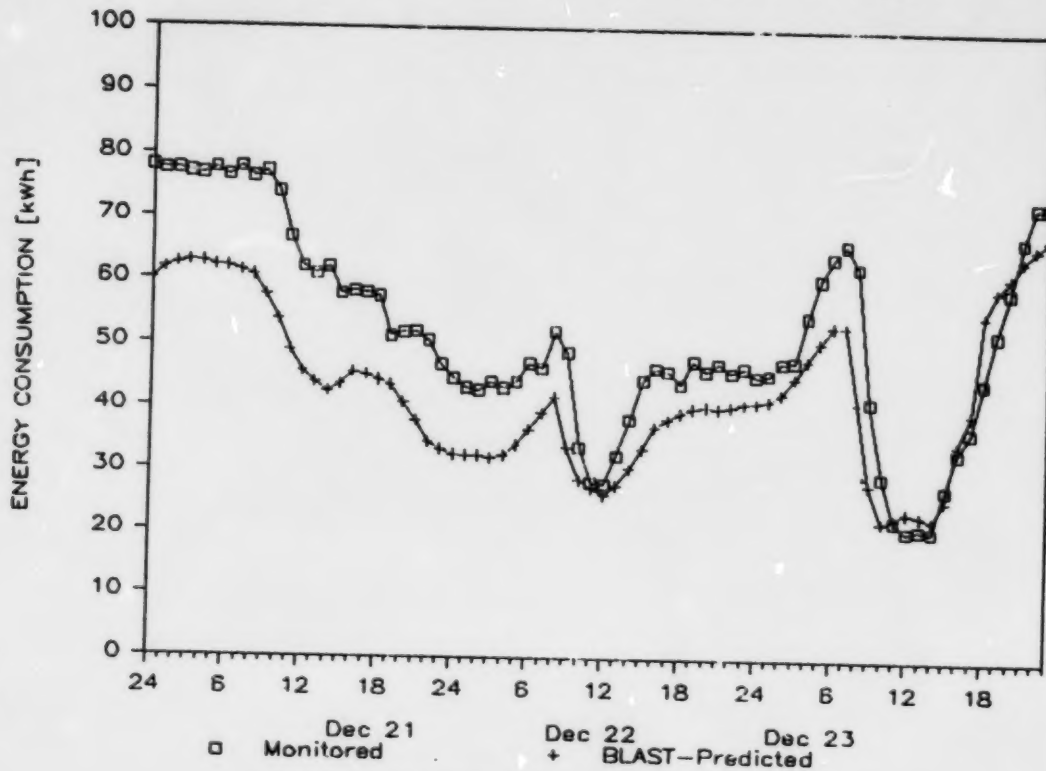


Figure 1.1.3 Auxiliary Heating Energy
December 21 - 26
Trial 3

AUXILIARY HEATING ENERGY



AUXILIARY HEATING ENERGY

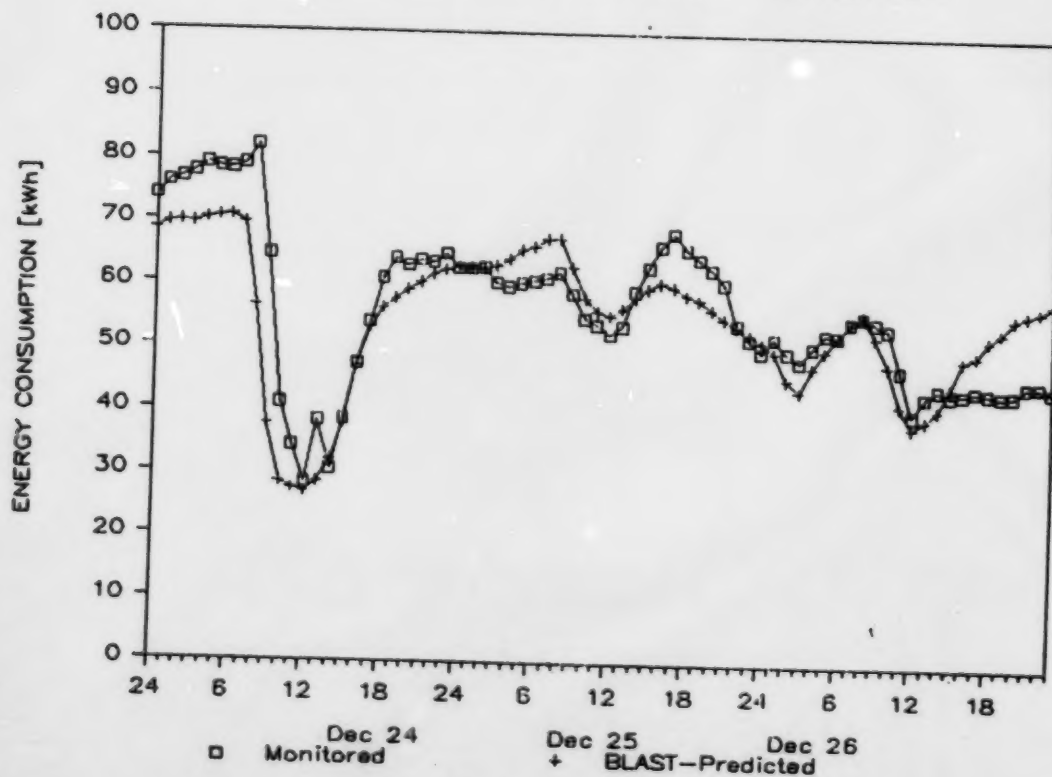
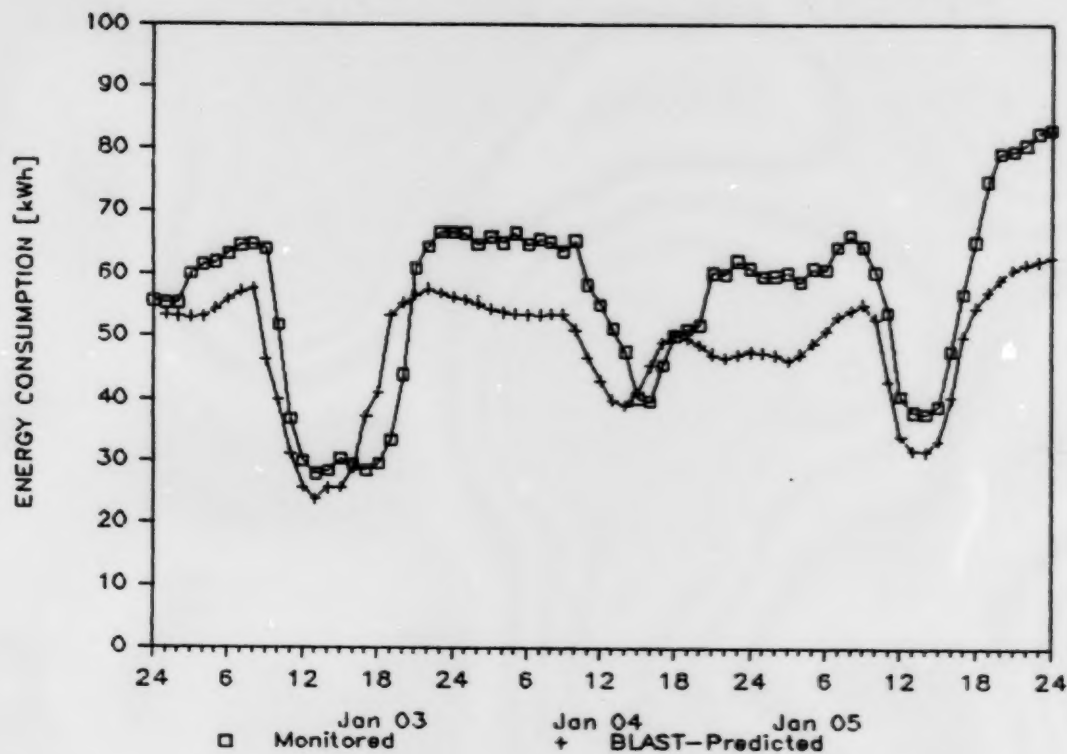


Figure 1.1.4 Auxiliary Heating Energy
December 21 - 26
Trial 4

AUXILIARY HEATING ENERGY



AUXILIARY HEATING ENERGY

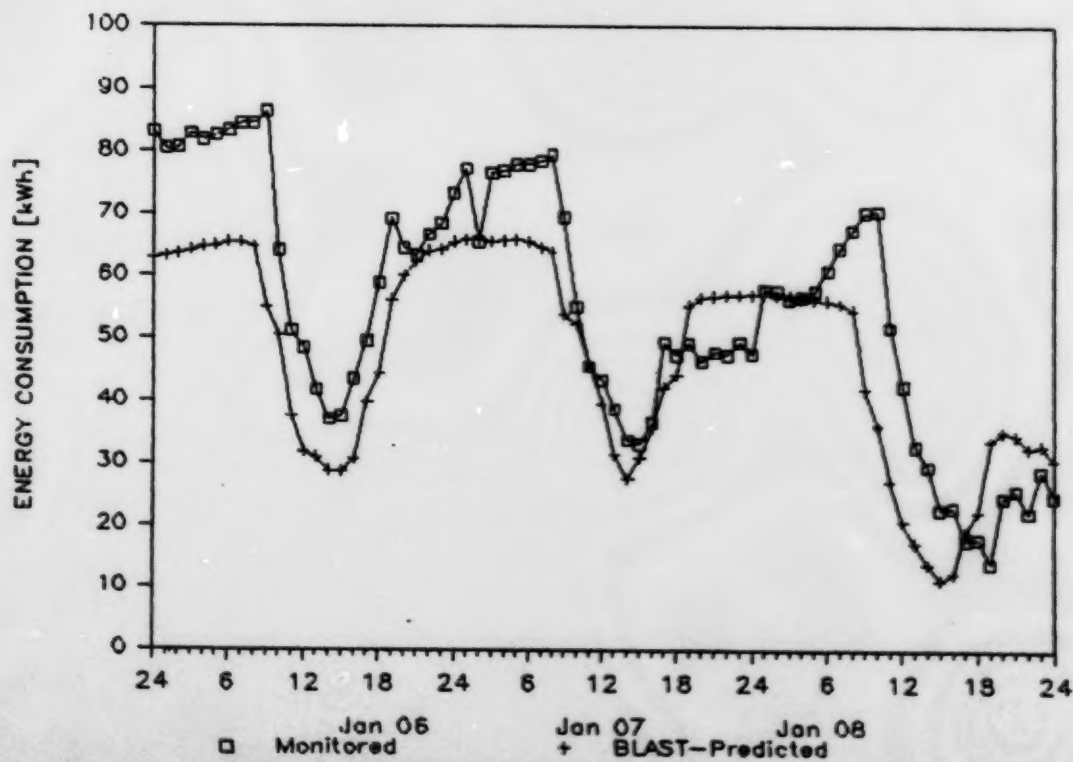
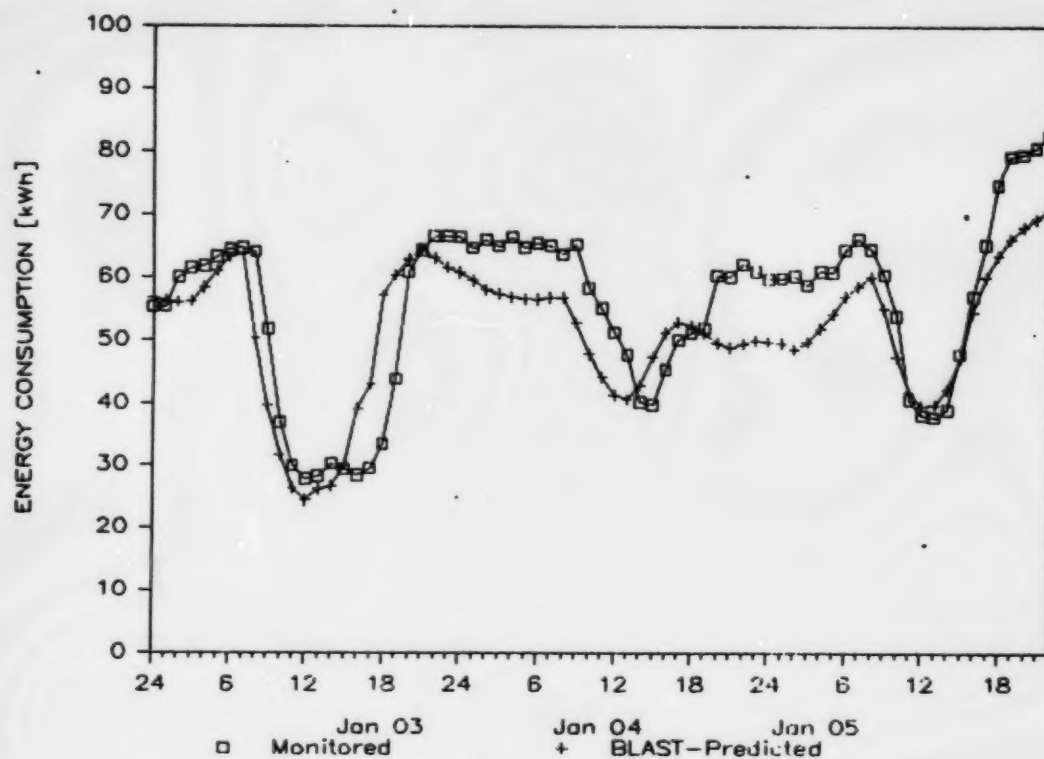


Figure 1.2.1 Auxiliary Heating Energy January 3 - 8

AUXILIARY HEATING ENERGY



AUXILIARY HEATING ENERGY

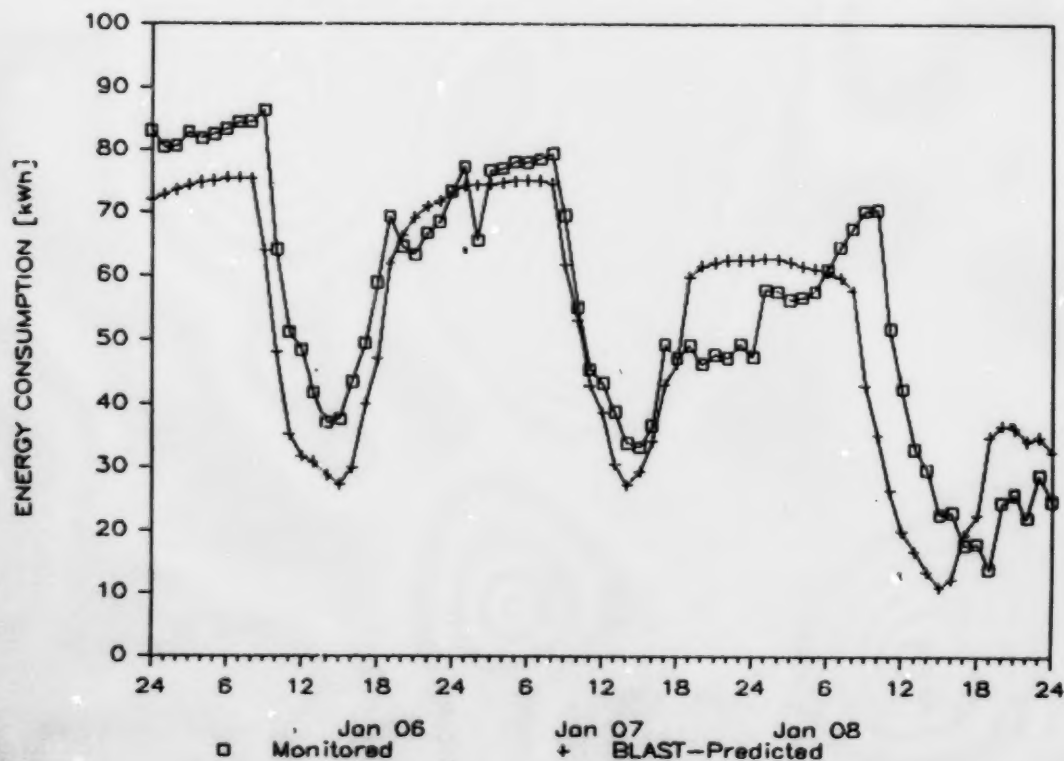
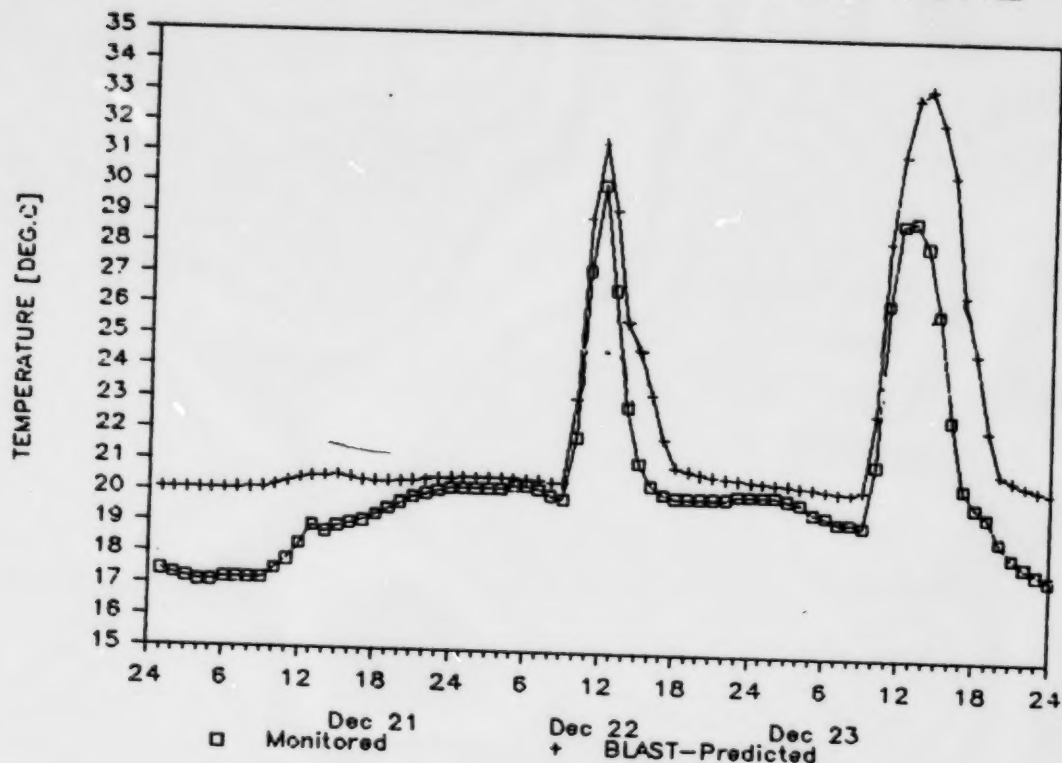


Figure 1.2.2 Auxiliary Heating Energy
January 3, 2003 to January 24, 2008

SOUTH CORRIDOR TEMPERATURE



SOUTH CORRIDOR TEMPERATURE

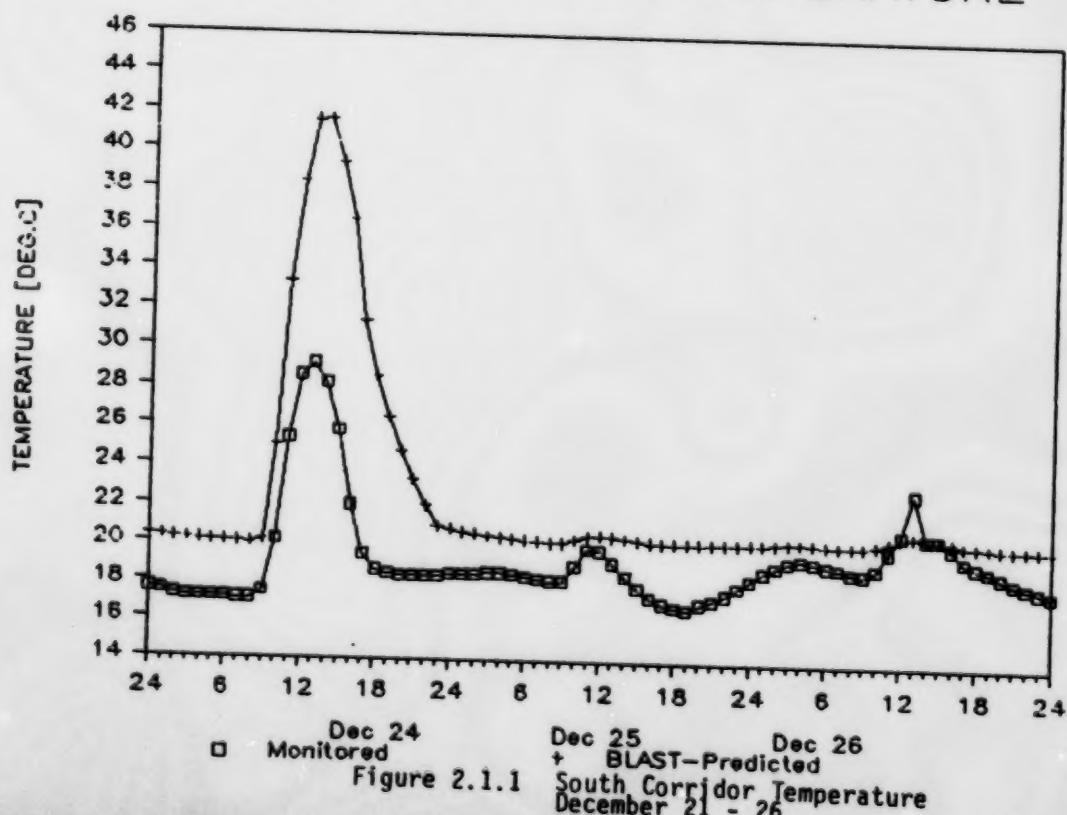
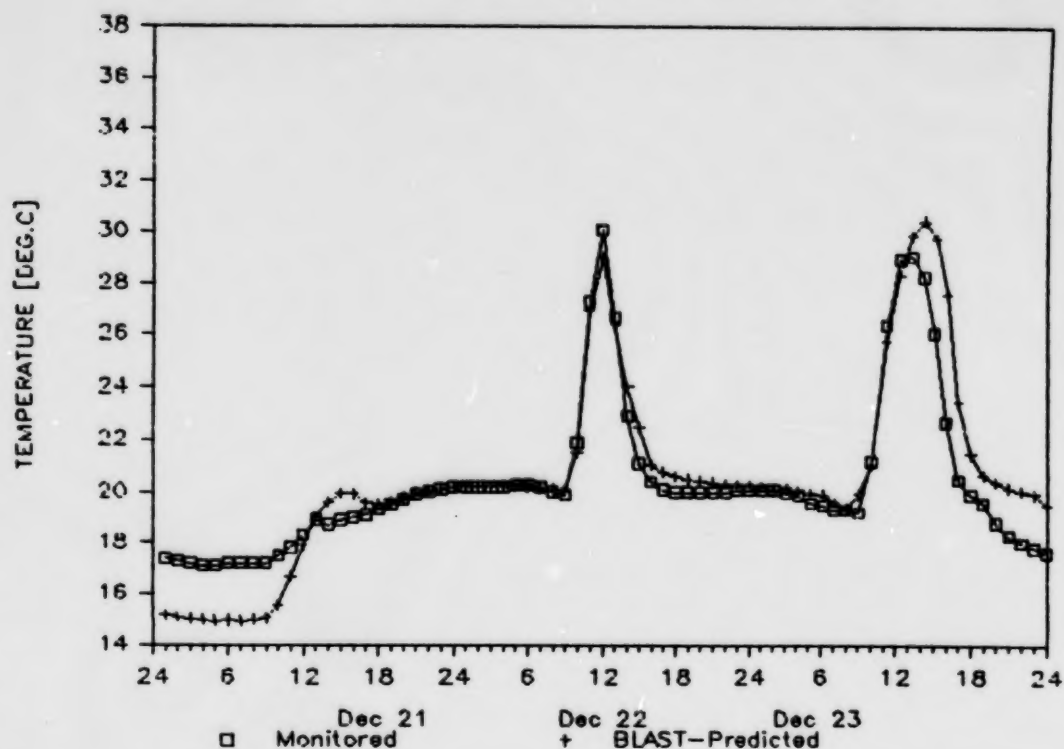


Figure 2.1.1

South Corridor Temperature
December 21 - 26

SOUTH CORRIDOR TEMPERATURE



SOUTH CORRIDOR TEMPERATURE

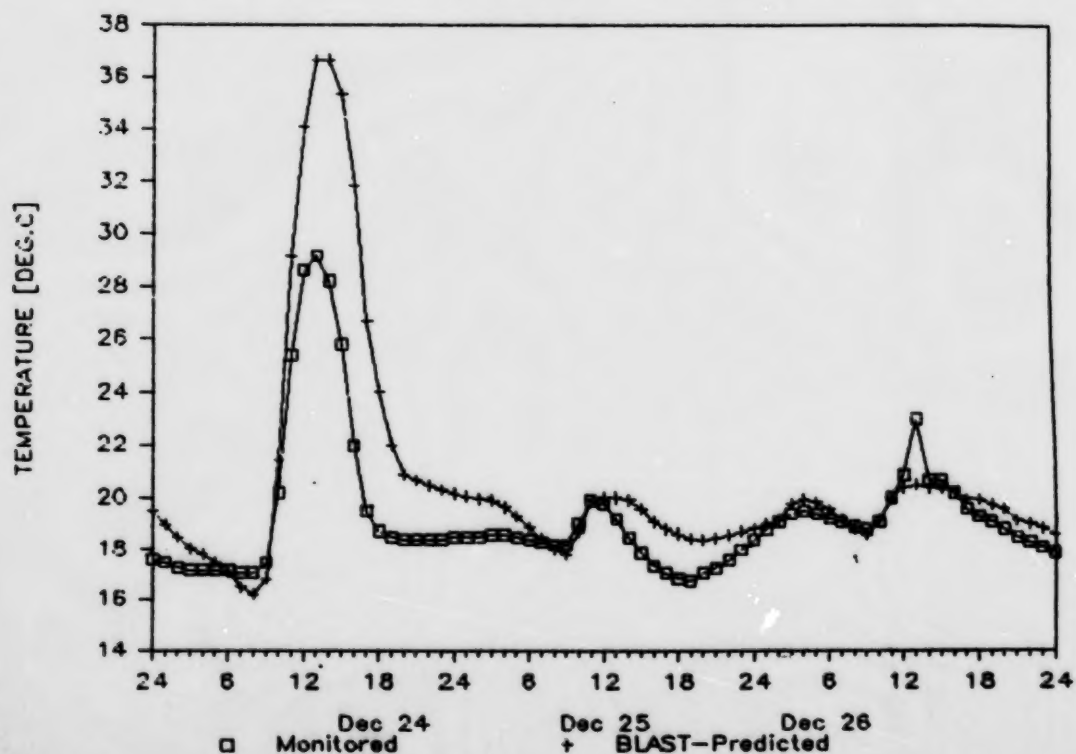
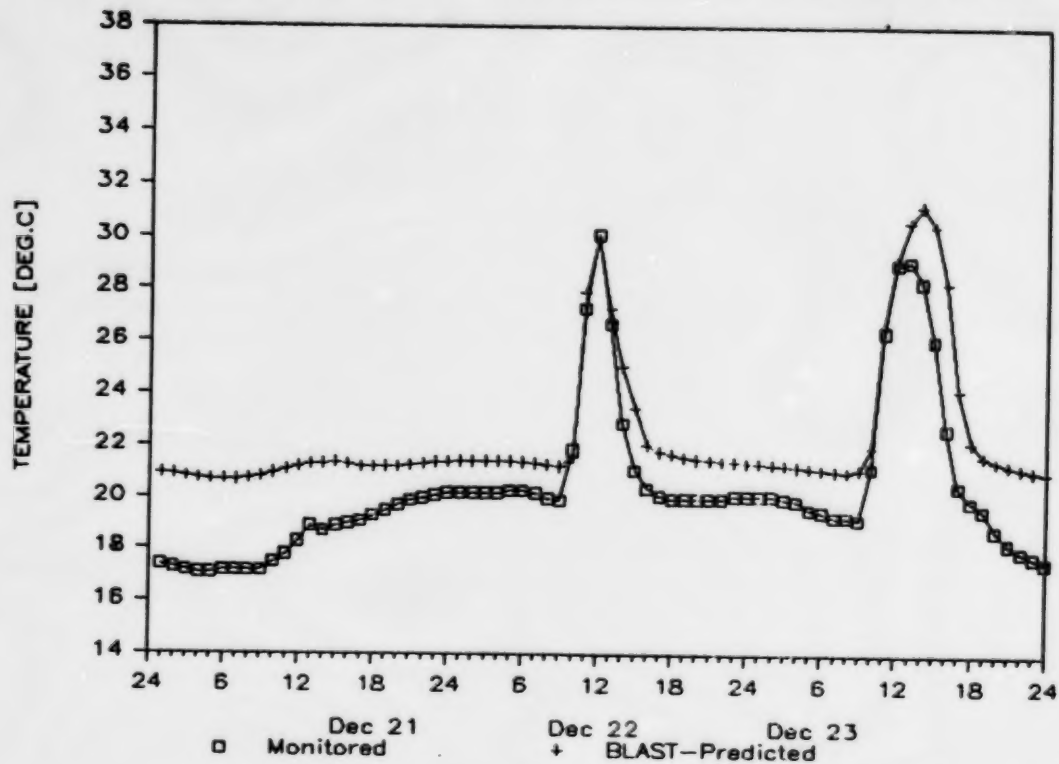


Figure 2.1.2 South Corridor Temperature
December 21 - 26
Trial 3

SOUTH CORRIDOR TEMPERATURE



SOUTH CORRIDOR TEMPERATURE

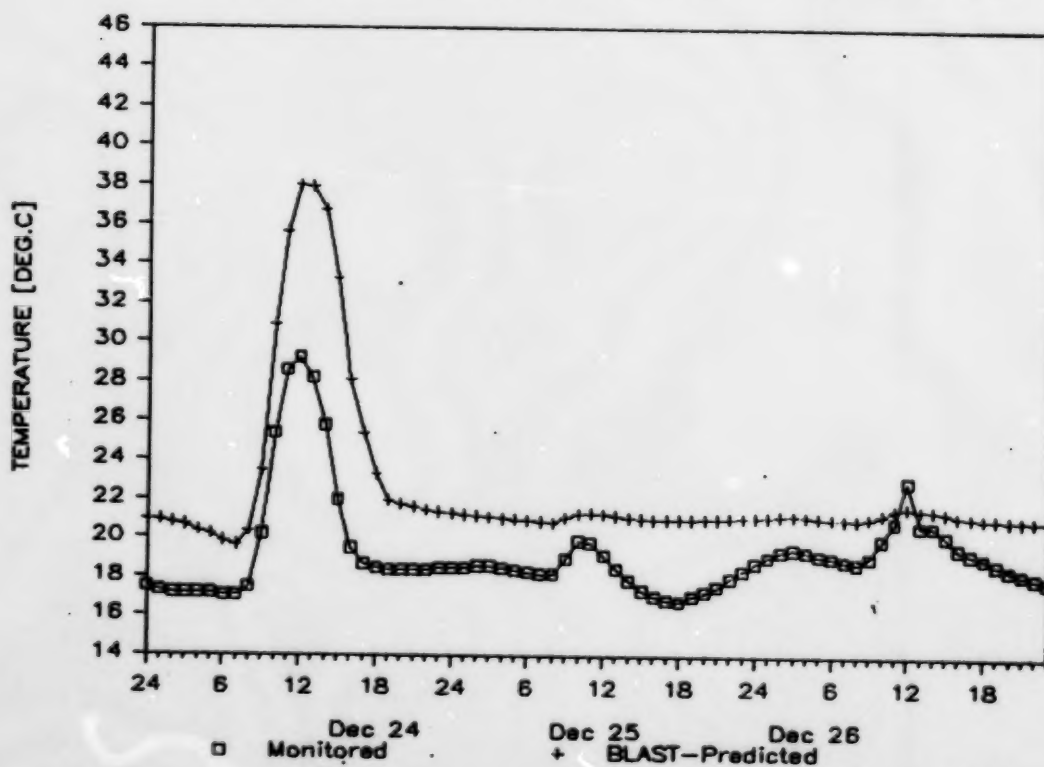
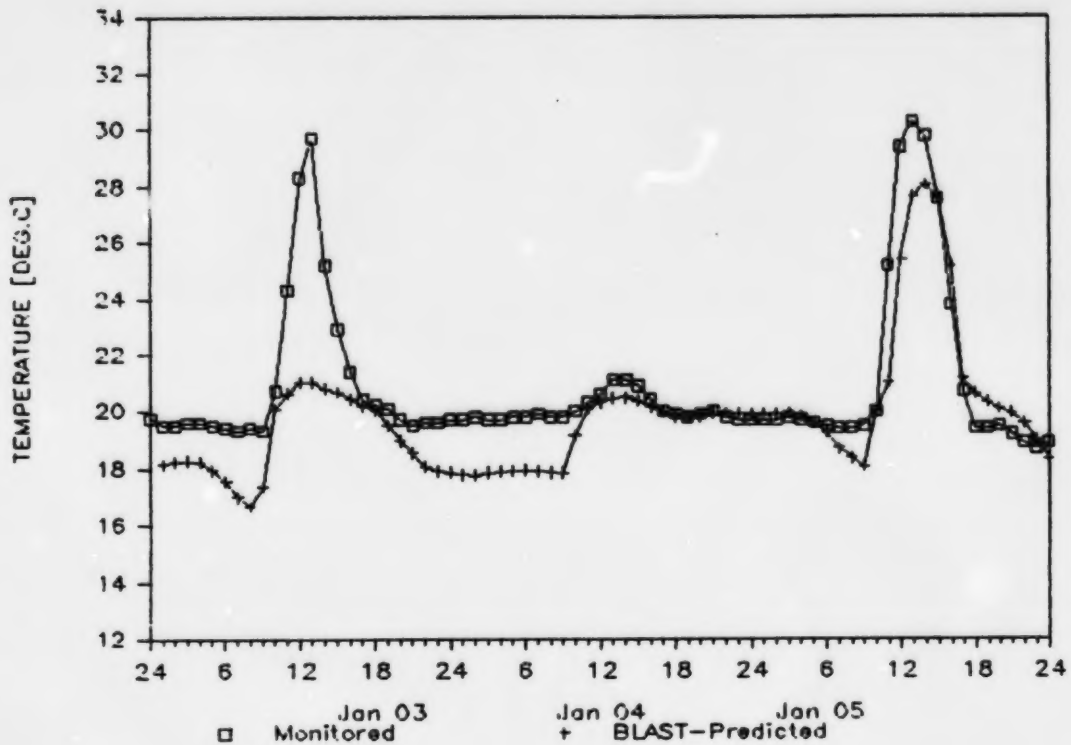


Figure 2.1.3 South Corridor Temperature
December 21 - 26
Trial 4

SOUTH CORRIDOR TEMPERATURE



SOUTH CORRIDOR TEMPERATURE

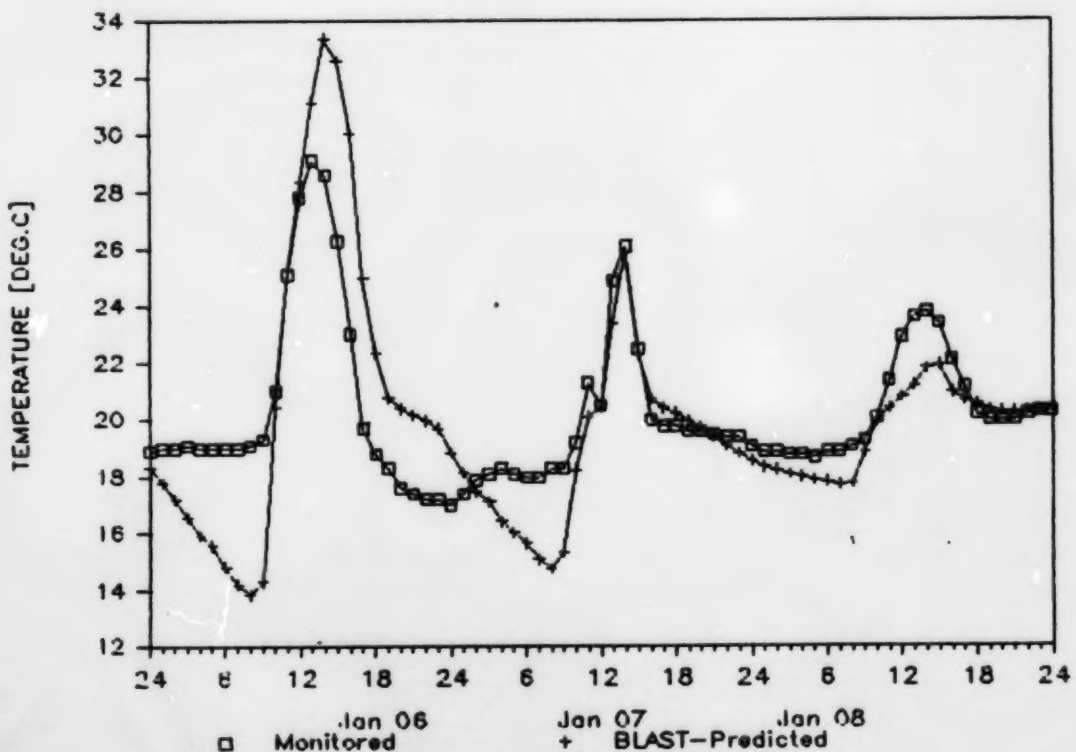
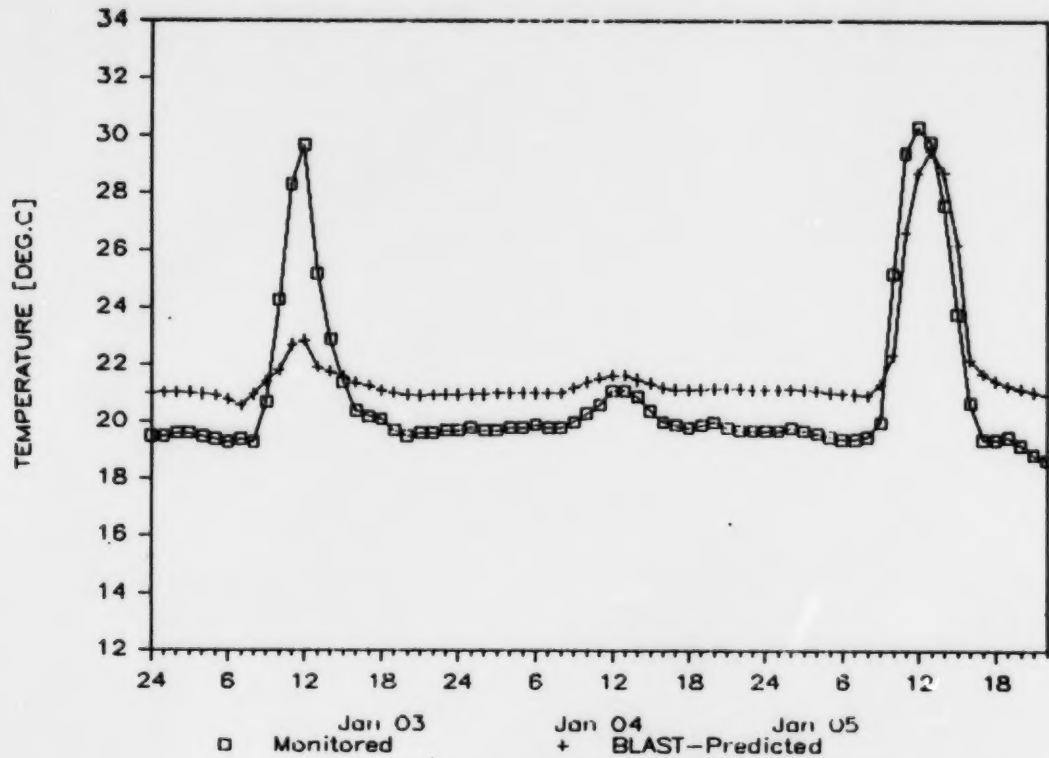


Figure 2.2.1 South Corridor Temperature
January 3 - 8 Trial 3

SOUTH CORRIDOR TEMPERATURE



SOUTH CORRIDOR TEMPERATURE

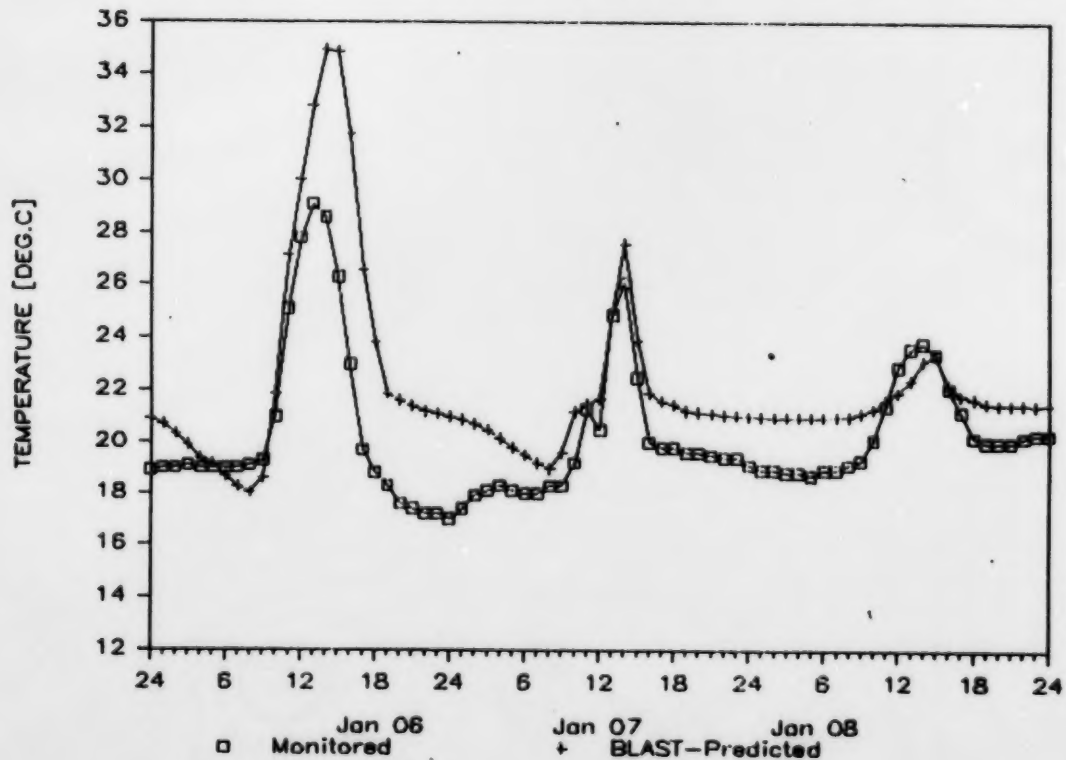
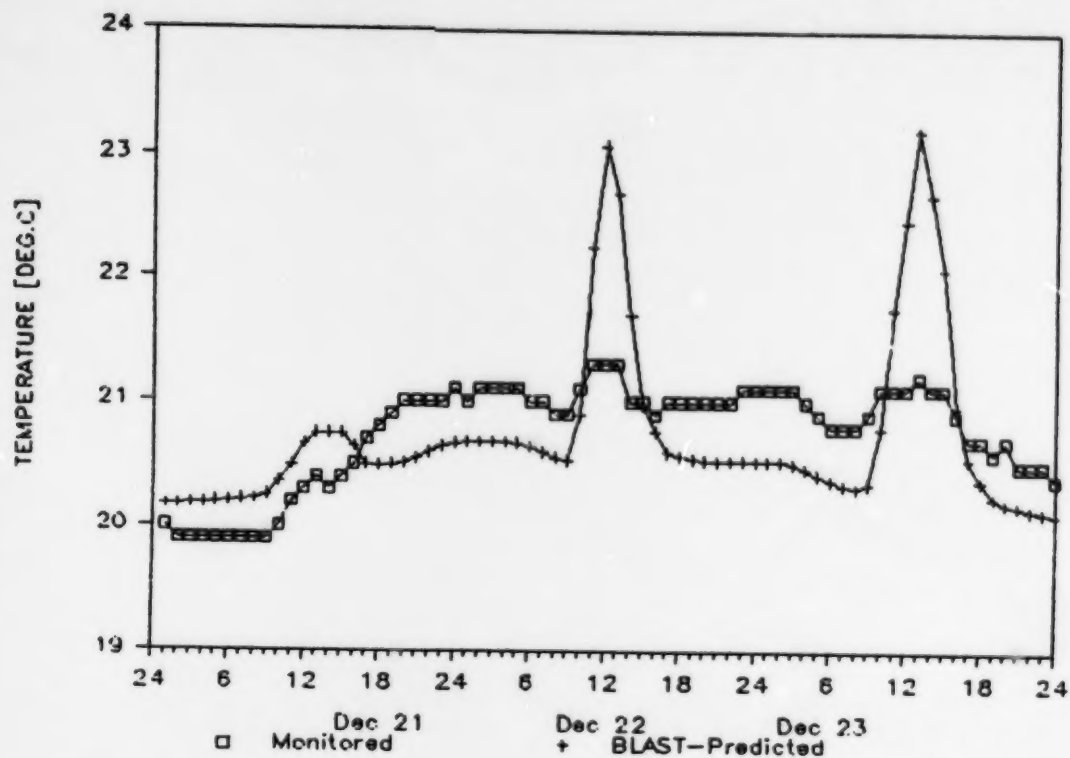


Figure 2.2.2 South Corridor Temperature
January 3 - 9
trial 4

CENTRAL ATRIUM TEMPERATURE



CENTRAL ATRIUM TEMPERATURE

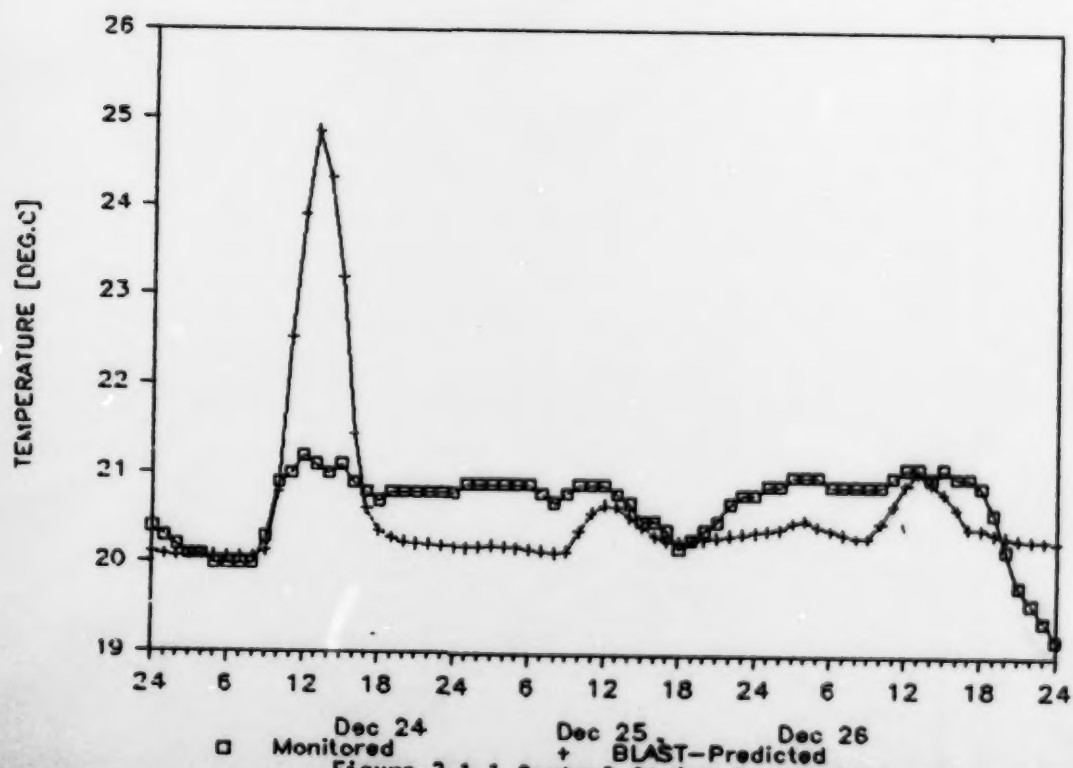
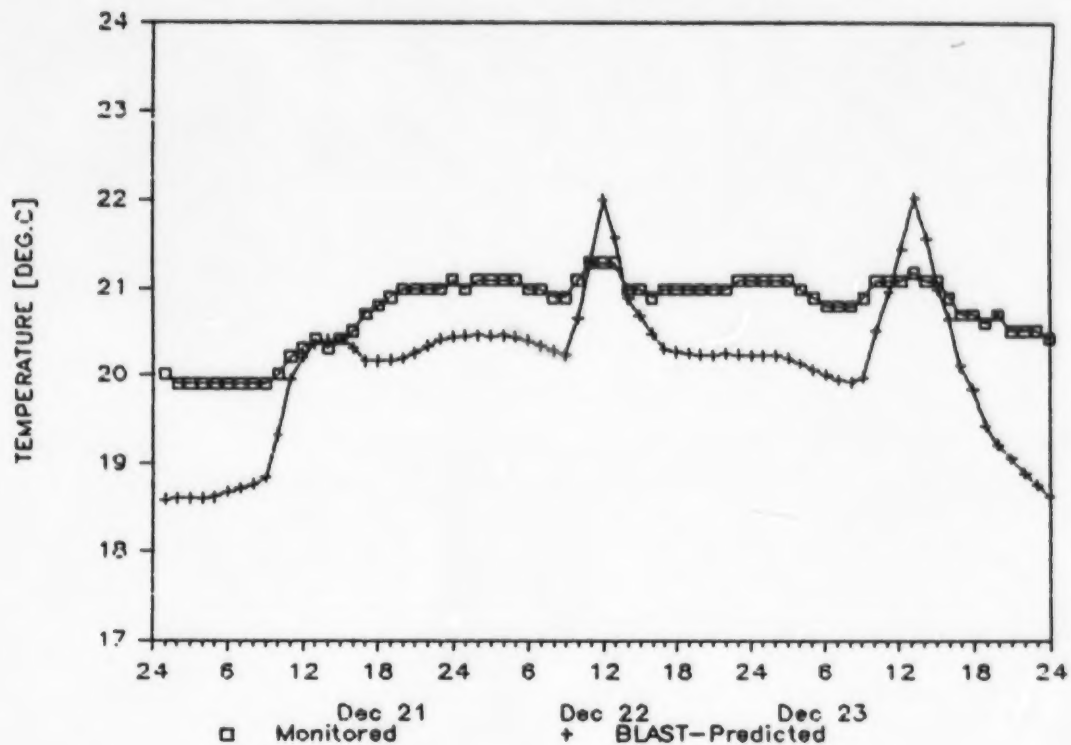


Figure 3.1.1 Central Atrium Temperature
December 21 - 26 Trial 2

CENTRAL ATRIUM TEMPERATURE



CENTRAL ATRIUM TEMPERATURE

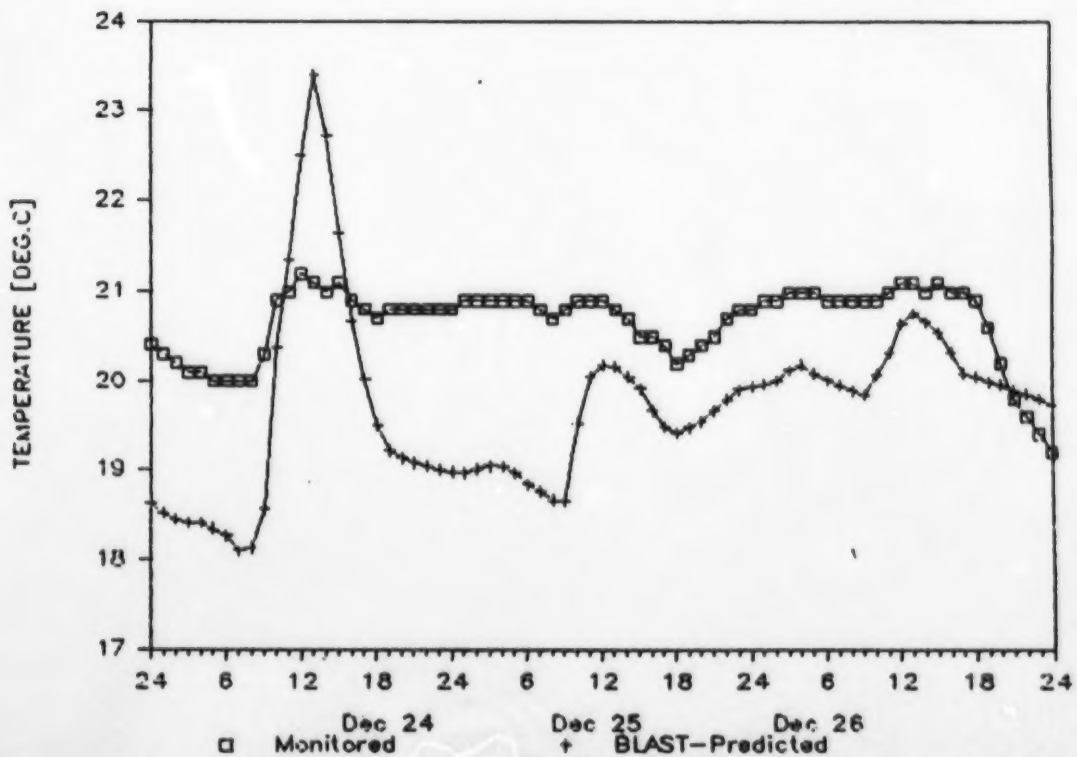
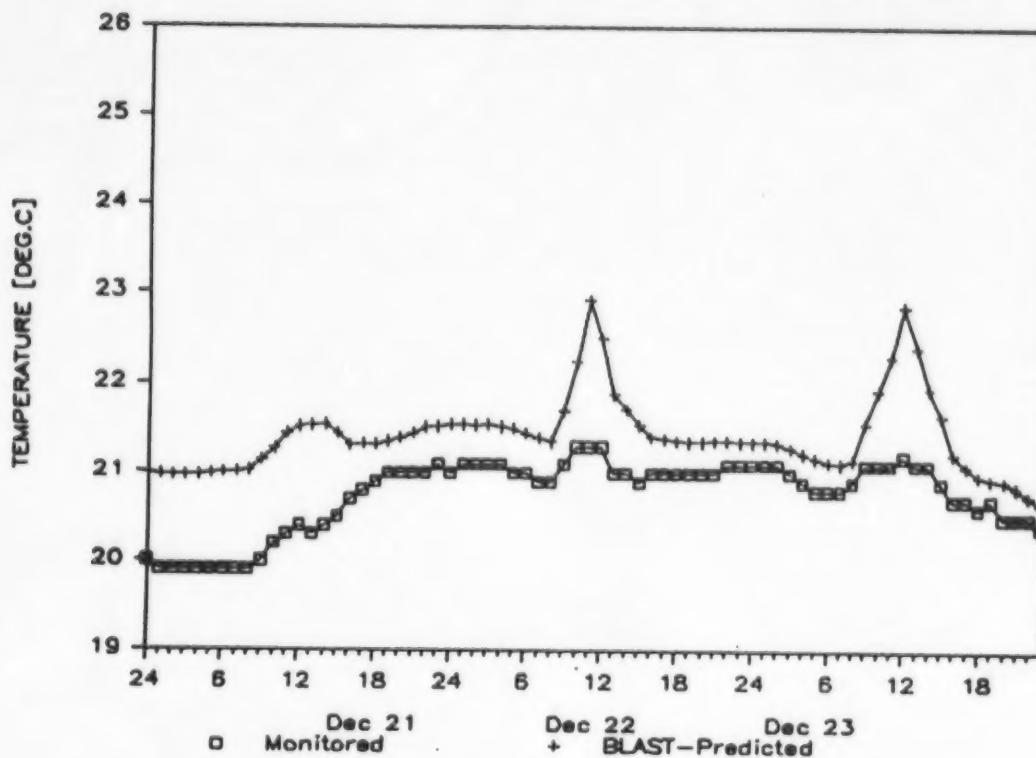


Figure 3.1.2 Central Atrium Temperature
December 21 - 26
Trial 3

CENTRAL ATRIUM TEMPERATURE



CENTRAL ATRIUM TEMPERATURE

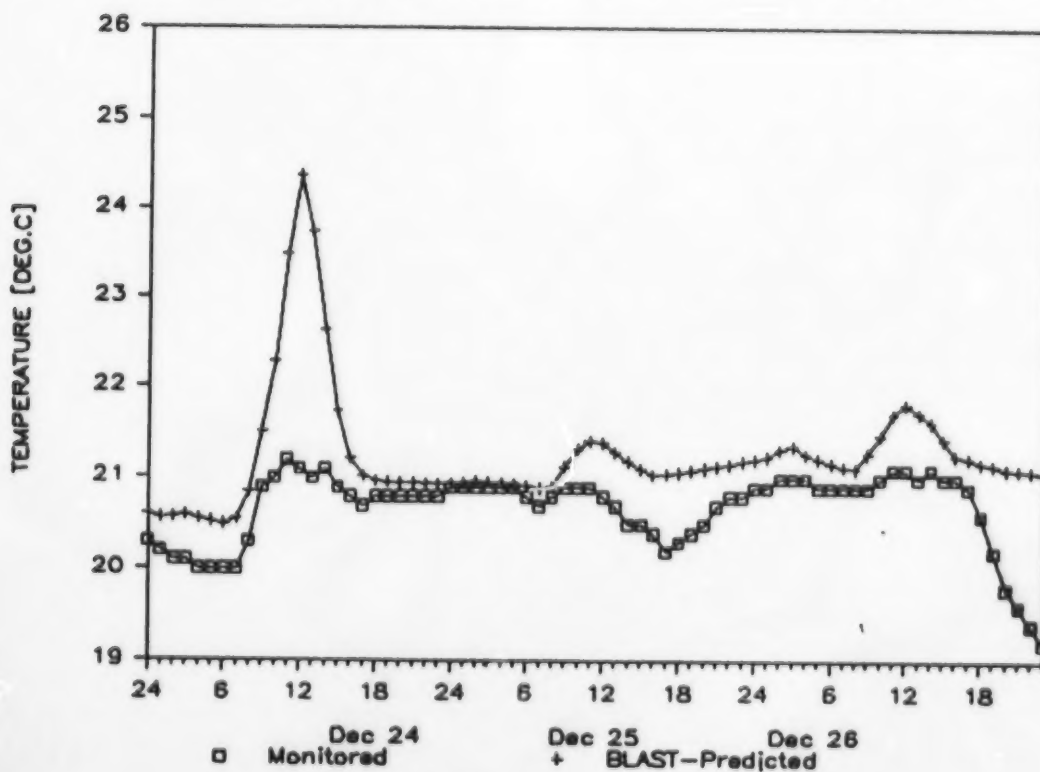
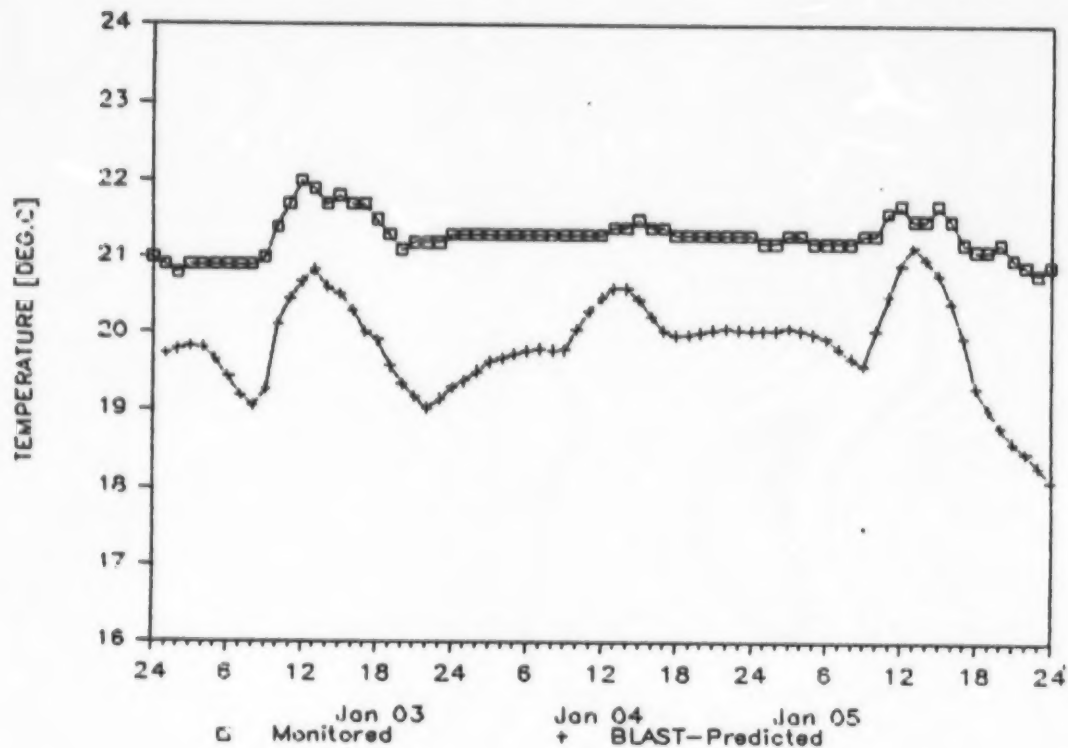


Figure 3.1.3 Central Atrium Temperature
December 21 - 26
Trial 4

CENTRAL ATRIUM TEMPERATURE



CENTRAL ATRIUM TEMPERATURE

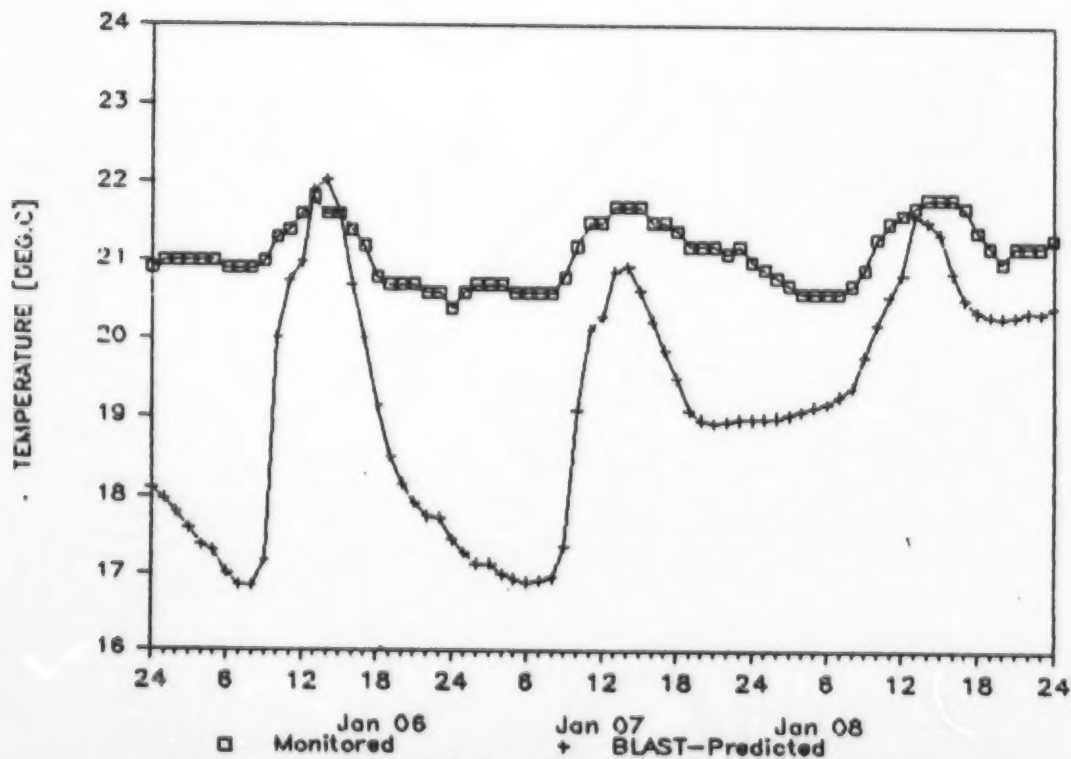
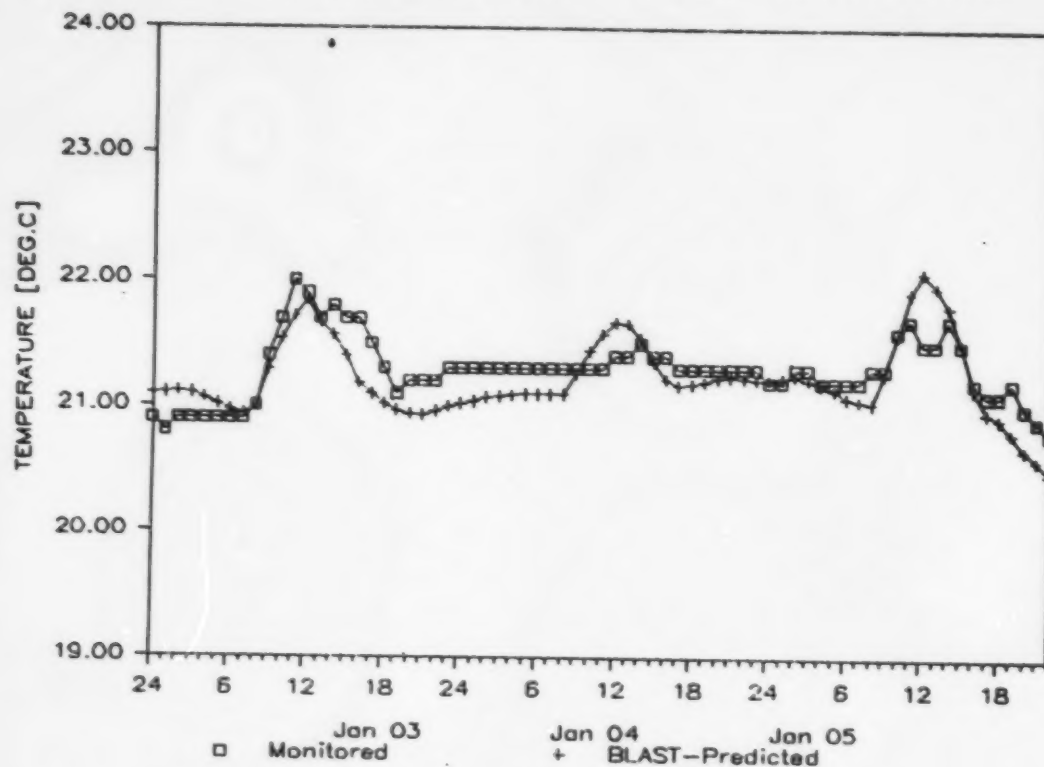


Figure 3.2.1

Central Atrium Temperature
January 3 - 8
Trial 3

CENTRAL ATRIUM TEMPERATURE



CENTRAL ATRIUM TEMPERATURE

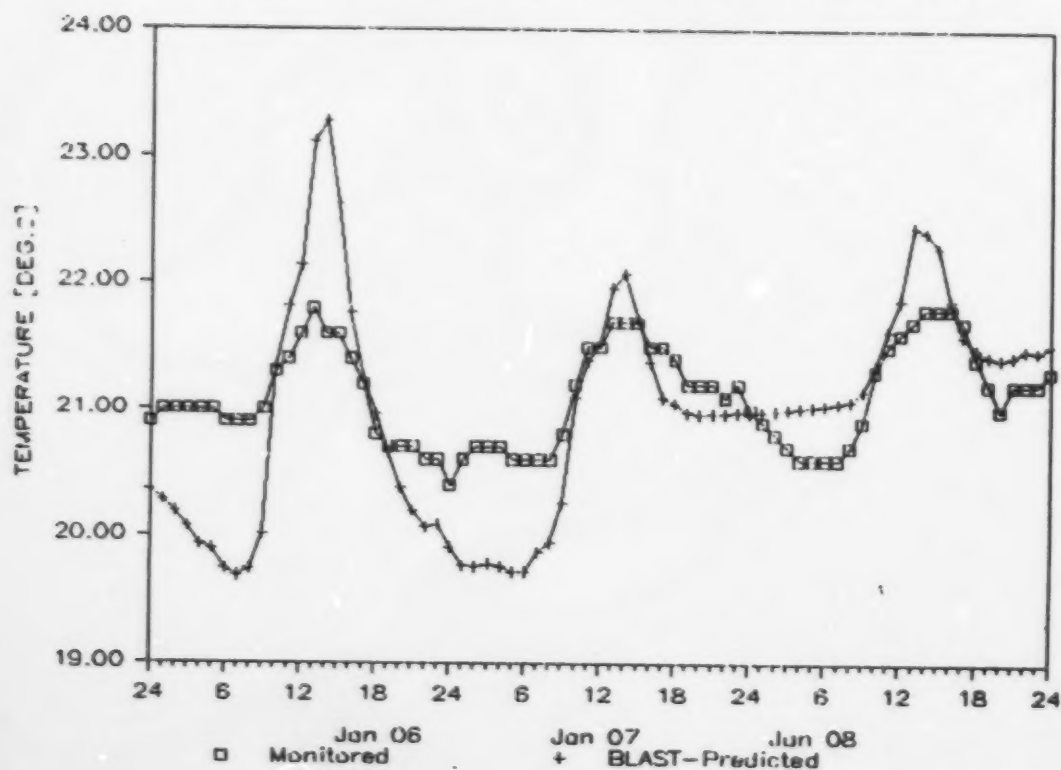
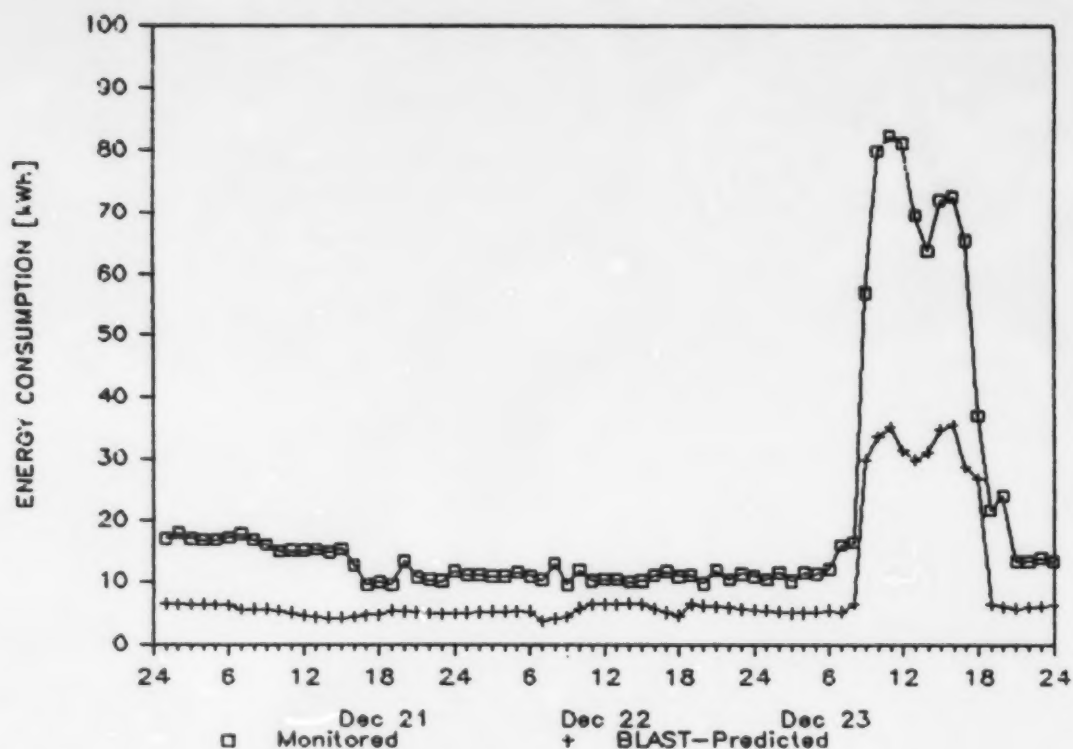


Figure 3.2.2 Central Atrium Temperature
January 3 - 8
Trial 4

INTERNAL ELECTRICAL ENERGY



INTERNAL ELECTRICAL ENERGY

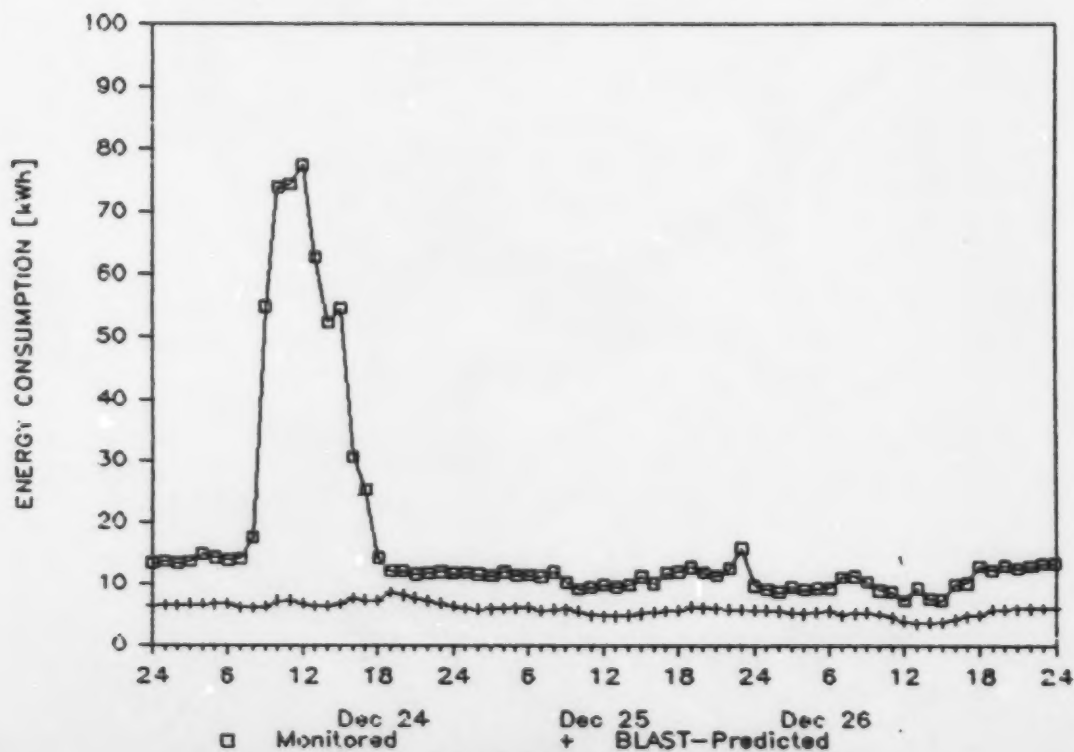
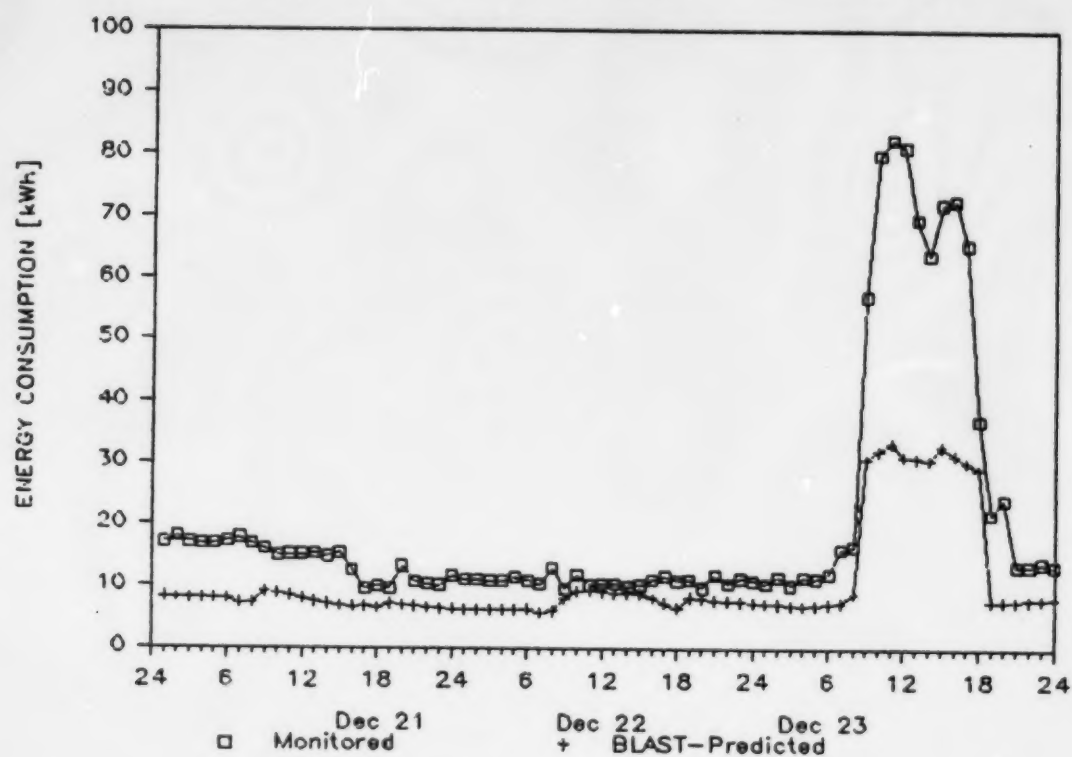


Figure 4.1.1 Internal Electrical Energy

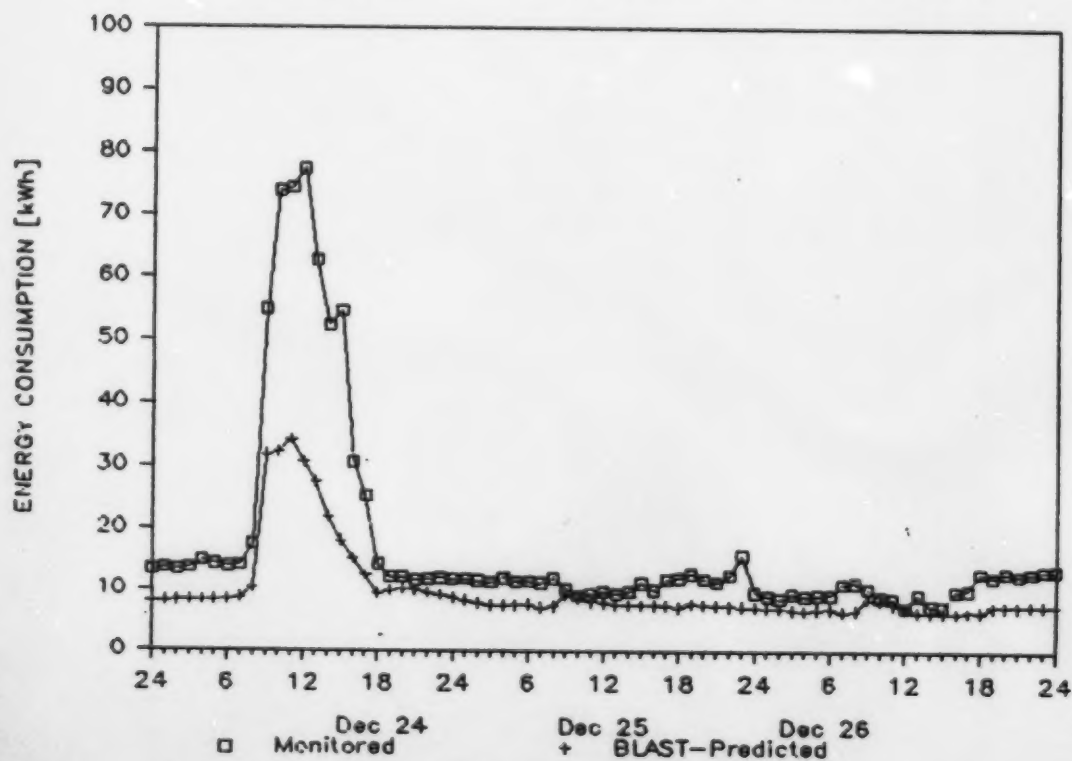
December 21 - 26

Trial 1

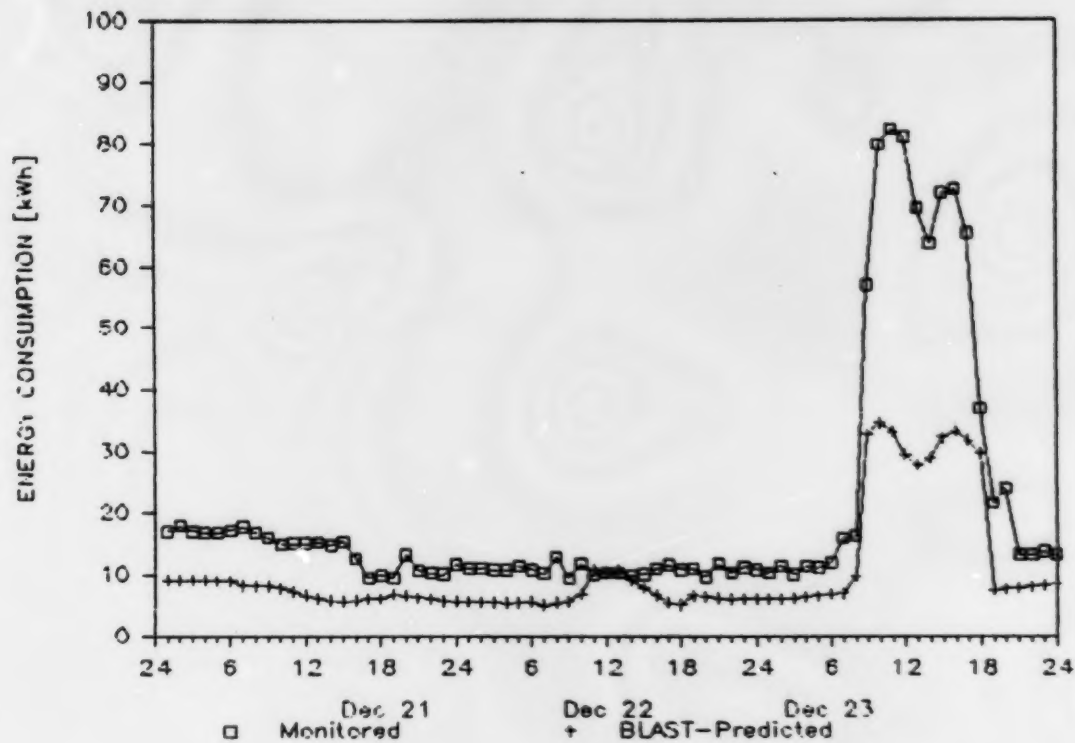
INTERNAL ELECTRICAL ENERGY



INTERNAL ELECTRICAL ENERGY



INTERNAL ELECTRICAL ENERGY



INTERNAL ELECTRICAL ENERGY

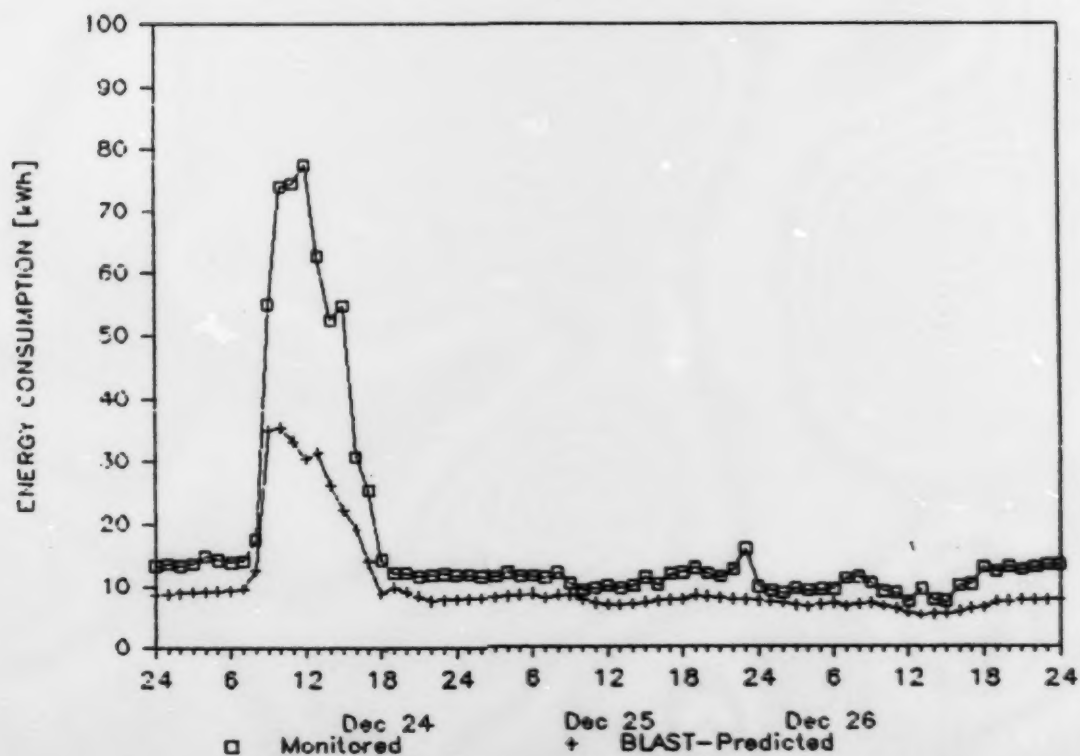
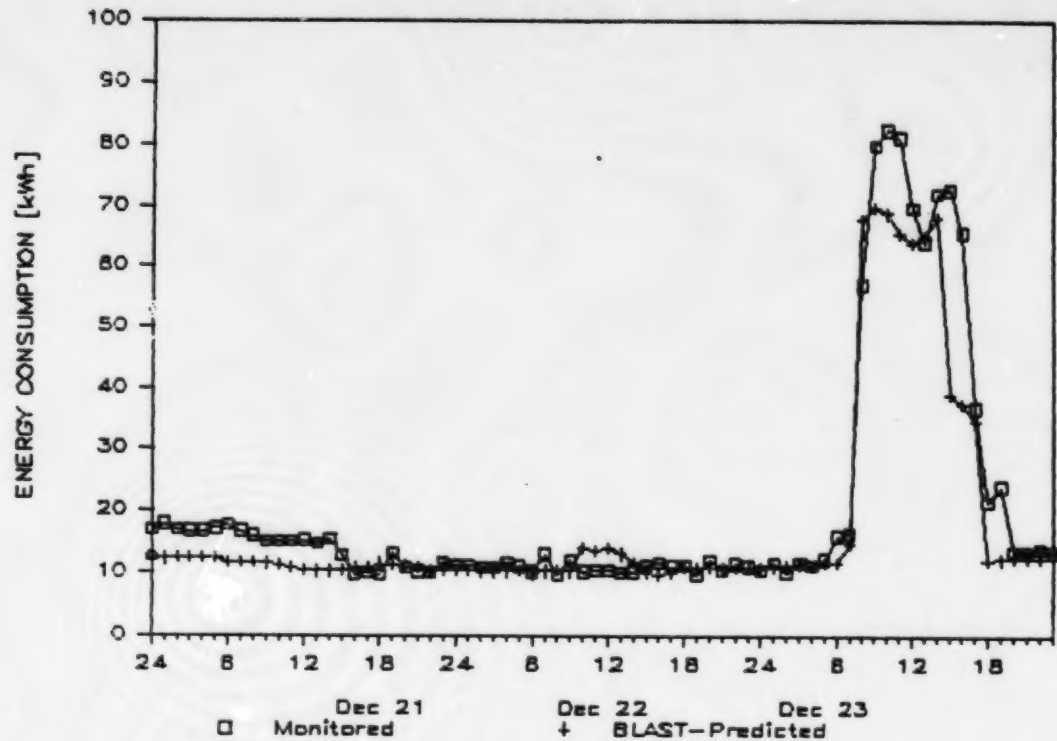


Figure 4.1.3 Internal Electrical Energy
December 21 - 26 Trial 3

INTERNAL ELECTRIC ENERGY



INTERNAL ELECTRIC ENERGY

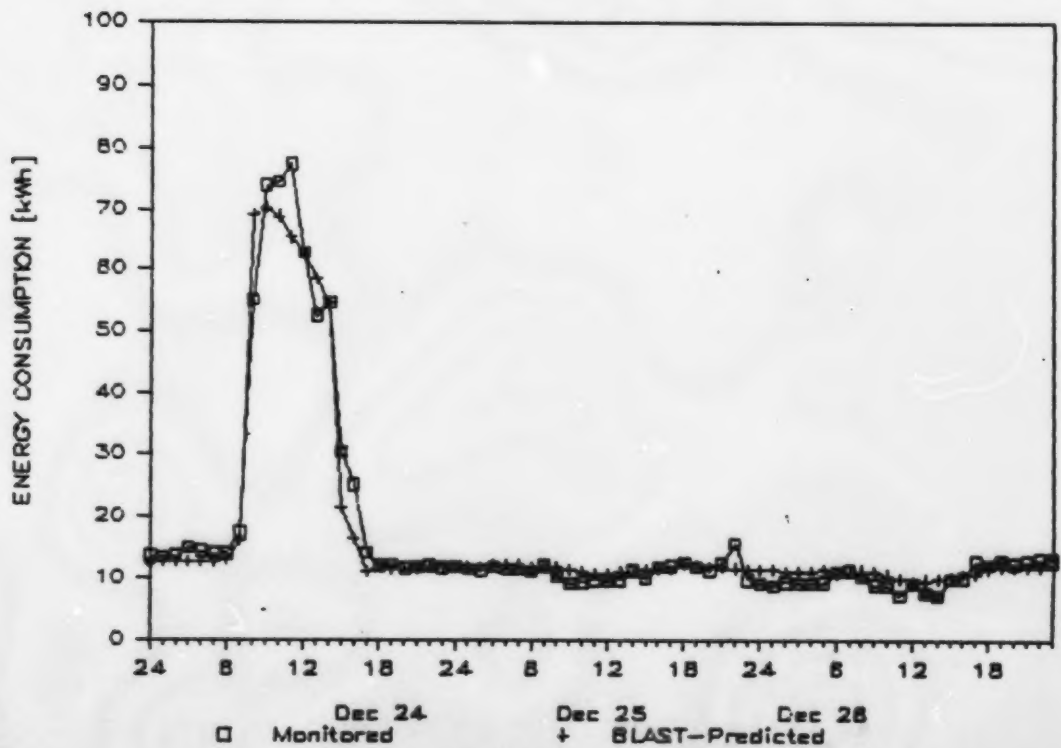
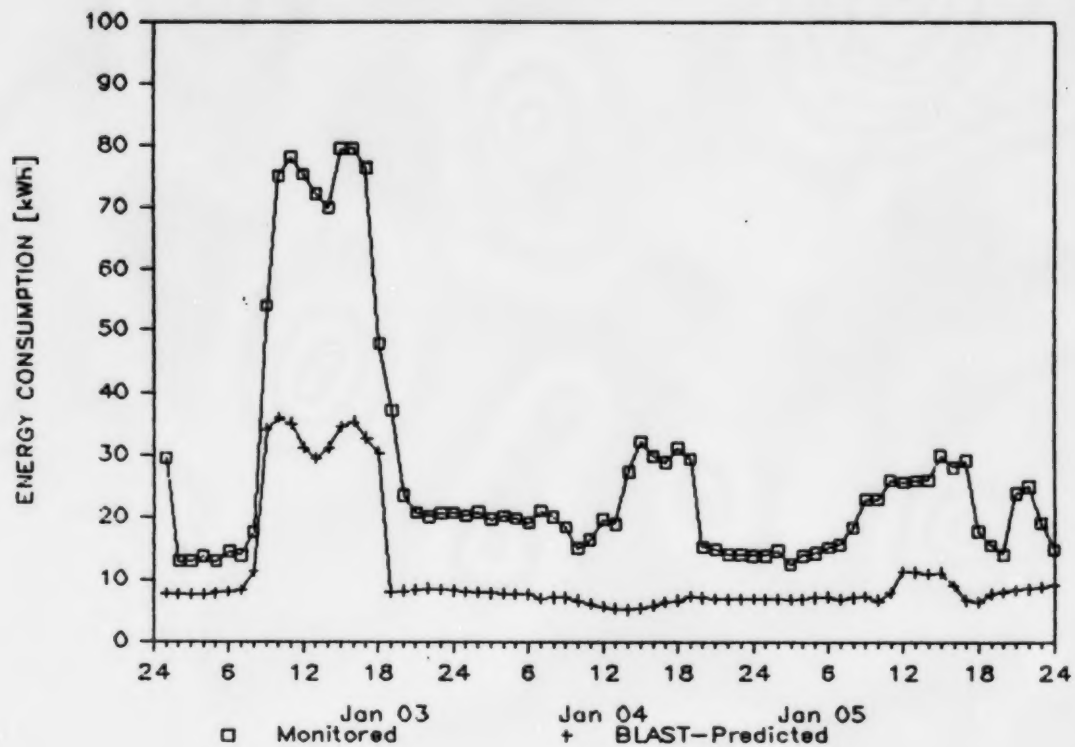


Figure 4.1.4 Internal Electrical Energy

INTERNAL ELECTRICAL ENERGY



INTERNAL ELECTRICAL ENERGY

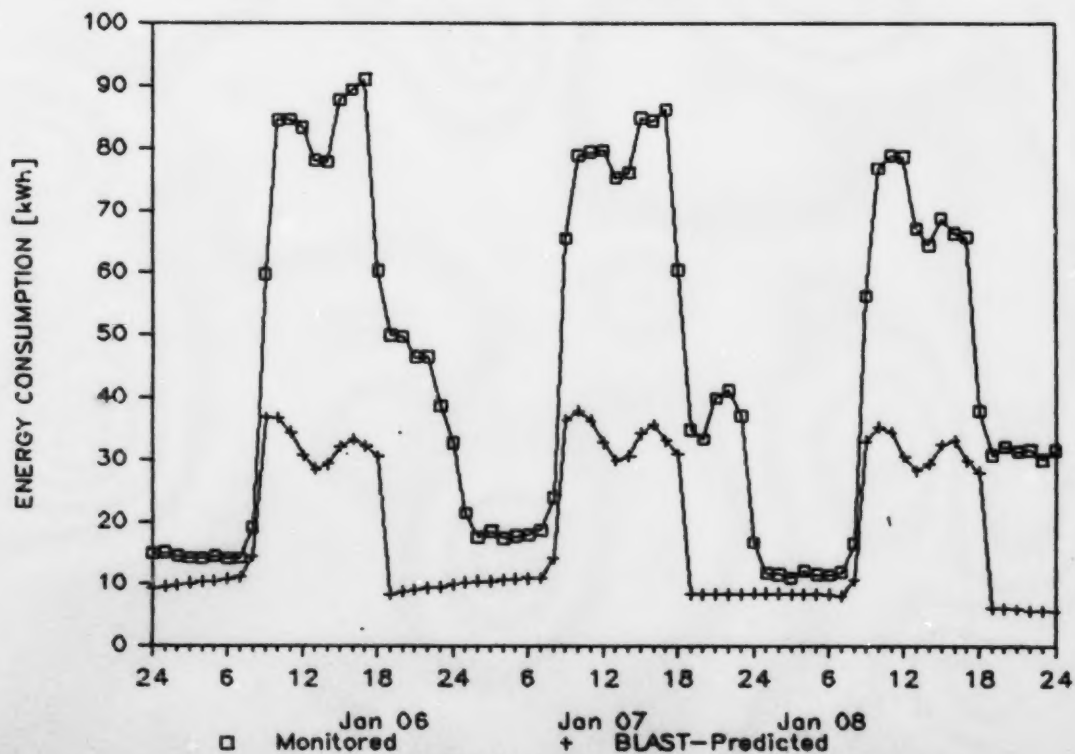
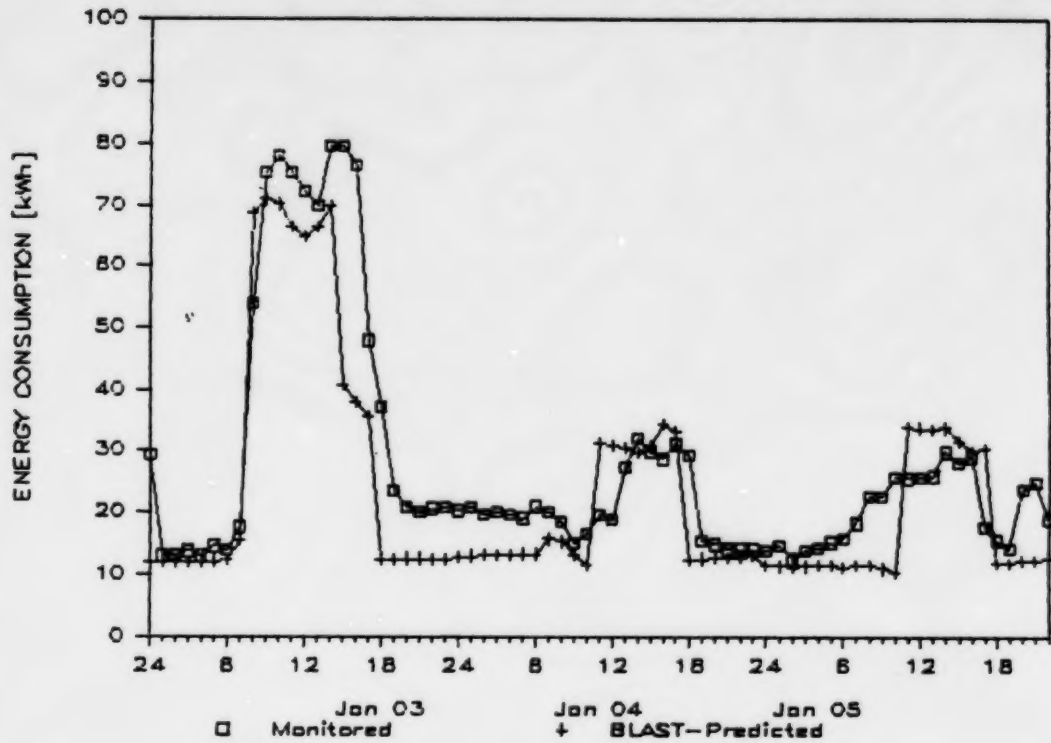


Figure 4.2.1 Internal Electrical Energy

INTERNAL ELECTRICAL ENERGY



INTERNAL ELECTRICAL ENERGY

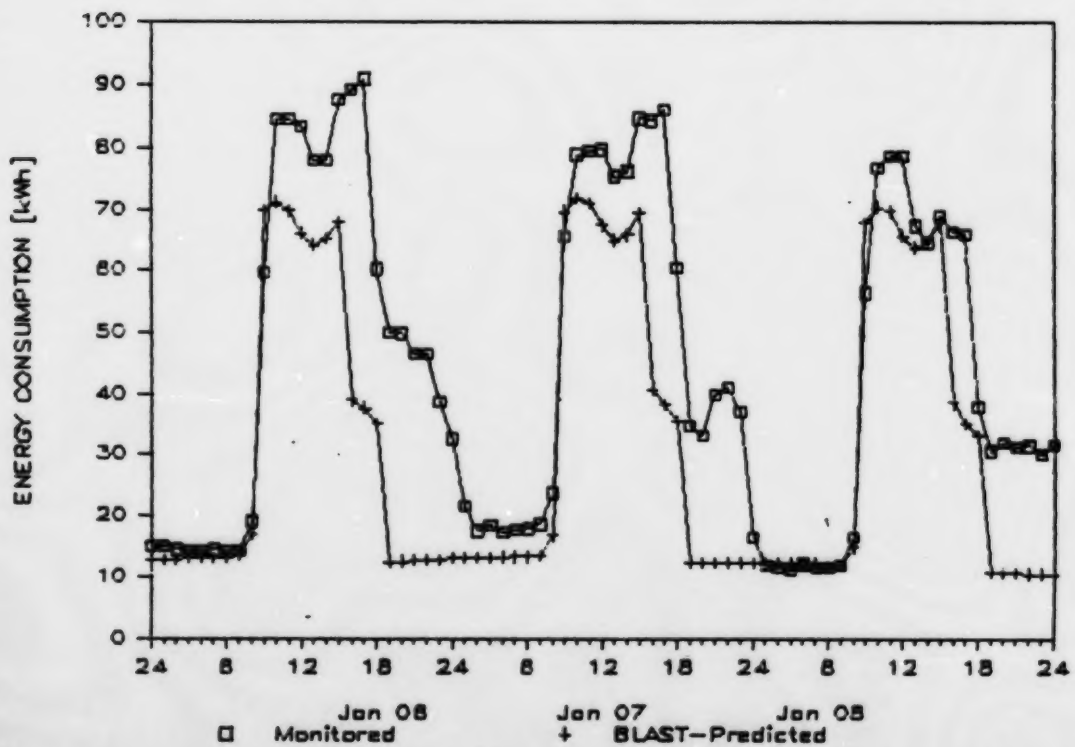


Figure 4.2.2 Internal Electrical Energy
January 3 - 8 Trial 4

APPENDIX

Calibrated Model

BLAST Input

US ARMY CORPS OF ENGINEERS -- BLAST VERSION 3.0 LEVEL 1.0 10 JUN 87 15.21.45. PAGE 1

1
2 ** S.K. YUILL AND ASSOCIATES LTD. **
3 ** JCB 8175 (OCTOBER 1986) M.Z. **
4 ** THERMAL PERFORMANCE PCELLING OF THE SMITH CARTER PARTNERS **
5 ** HEAD OFFICE BUILDING IN WINNIPEG USING A CALIBRATED MODEL **
6 ** BLAST INPUT FILE -- BUILDING DESCRIPTION **
7 ** LATEST FILE UPDATED DECEMBER 5, 1986 **
8
9 **
10 ** RLM CONTROL BLOCK
11 **
12 BEGIN INPUT:
13 RUN CONTROL
14 MEN JONES
15 REPORTS (WALLS,ZONE).
16 UNITS (METRIC):
17 **
18 ** LIBRARY MODIFICATION BLOCK
19 **
20 DEFINE LOCATIONS
21 WINNIPEG = (LAT=49.833, LONG=97.233, TZ=6):
22 ENC:
23 DEFINE DESIGN DAYS:
24 WINNIPEG SUMMER = (HIGH=J2, LOW=J3, DATE=21 JUL, PRES=10000,
25 CLEARNESS=1.0, WEEKDAY).
26 WINNIPEG WINTER = (HIGH=J3, LOW=J4, DATE=21 JAN, PRES=10000,
27 CLEARNESS=0.3, SNOW, WEEKDAY):
28 ENC:

29 ** LIBRARY MODIFICATIONS - MATERIAL DEFINITIONS

30 **
31 **
32 DEFINE MATERIALS:

33 ALUM FANEL 1/8 IN. (R=0.000143, ABS=0.14, TABS=0.9, SEC=0.01).

34 ** THERMAL RESISTANCE OF R12 FOR 3 1/2 IN. GLASS FIBRE BATT INSULATION DECREASED

35 ** TO AN EFFECTIVE VALUE OF R10 TO ACCOUNT FOR THE EFFECT OF THE STEEL

36 ** STUDS

37 INSULATION - GLASS FIBRE BATT 3 1/2 IN. (R=1.76, ABS=0.50, TABS=0.91,

38 VERY ROUGH).

39 ** THERMAL RESISTANCE OF R8 FOR 1 1/2 IN. GLASS FIBRE BATT INSULATION

40 ** DECREASED TO AN EFFECTIVE VALUE OF R6.2 TO ACCOUNT FOR THE WOOD

41 ** STRAPPING

42 INSULATION - GLASS FIBRE BATT 1 1/2 IN. (R=1.1, ABS=0.58, TABS=0.98,

43 VERY ROUGH).

44 INSULATION - EXPANDED EXT POLYSTYRENE 5 IN. (K=3.25, ABS=0.5, TABS=0.90,

45 ROUGH).

46 INSULATION - EXPANDED EXT POLYSTYRENE 1 1/2 IN. (R=1.06, ABS=0.50,

47 TABS=0.90, ROUGH).

48 INSULATION - BODE FIBERBOARD 1/2 IN. (R=0.272, ABS=0.6, TABS=0.9, VERY

49 ROUGH).

50 ** SOME UNCERTAINTY IN INDEX OF REFRACTION FOR KALMALL

51 GLASS - KALMALL 2 3/4 IN. (R=0.44, TABS=0.90, TRANS=0.22, IRS=0.27,

52 GLASS, SMOOTH).

53 CONCRETE PM 10 IN. (L=0.284, K=1.73, CP=0.037, D=2243, TABS=0.90, ABS=0.65,

54 MEDIUM ROUGH).

55 CONCRETE PM 5 1/2 IN. (L=0.140, K=1.73, CP=0.037, D=2243, TABS=0.90, ABS=0.65,

56 MEDIUM ROUGH).

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57 CONCRETE PW 3 IN = (L=0.0762,K=1.73,CP=0.837,0=2243,TABS=0.96,ABS=0.65,
58 MEDIUM ROUGH).

59 GLASS = INDOOR CLEAR PLATE 1/4 IN = (L=0.00619,K=0.767,CP=0.756,0=2500.,
60 TABS=0.98,TRANS=0.88,IG=1.52,CLASS=VERY SMOOTH).

61 BUILDING BOARD = GYPSUM PLASTER 5/8 IN = (L=0.0159,K=0.162,CP=0.837,
62 G=880.9,TABS=3.90,ABS=0.75,MEDIUM SMOOTH).

63 ENCL

65 ** LIBRARY SPECIFICATIONS = CONSTRUCTION ELEMENTS

66 **

67 DEFINE WALLS

68 EXTMALL1 = ALUM PANEL 1/8 IN, BUILDING BOARD -

69 GYPSUM PLASTER 1/2 IN, INSULATION - GLASS FIBER BATT 3 1/2 IN, BUILDING

70 BOARD - GYPSUM PLASTER 1/2 IN).

71 EXTMALL2 = (CONCRETE MW 10 IN, INSULATION - GLASS FIBER BATT

72 1 1/2 IN, BUILDING BOARD - GYPSUM PLASTER 1/2 IN).

73 EXTMALL4 = ALUM PANEL 1/4 IN, BUILDING BOARD - PLYWOOD 1/2 IN, INSULATION -

74 GLASS FIBER BATT 3 1/2 IN, BUILDING BOARD - GYPSUM PLASTER 1/2 IN).

75 EXTMALL5 = (CONCRETE MW 10 IN, INSULATION - EXPANDED POLYSTYRENE

76 1 1/2 IN).

77 EXTMALL6 = (BUILDING BOARD - GYPSUM PLASTER 1/2 IN, INSULATION - GLASS

78 FIBER BATT 3 1/2 IN, CONCRETE MW 10 IN).

79 EXTMALL7 = ALUM PANEL 1/4 IN, INSULATION - GLASS FIBER BATT 3 1/2 IN).

80 EXTMALL8 = (CONCRETE MW 10 IN).

81 PARTITION1 = (BUILDING BOARD - GYPSUM PLASTER 1/2 IN, 01 - AIRSPACE

82 RESISTANCE, BUILDING BOARD - GYPSUM PLASTER 1/2 IN).

83 PARTITION2 = (BUILDING BOARD - GYPSUM PLASTER 5/8 IN, 01 - AIRSPACE

84 RESISTANCE, BUILDING BOARD - GYPSUM PLASTER 5/8 IN).

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85 PARTITION99 = (GLASS - INCCOR CLEAR PLATE 1/4 IN):

86 ENCI

87 DEFINE ROOFS1

88 CEILING1 = (CONCRETE HW 3 IN).

89 CEILING2 = (CONCRETE HW 3 IN, E4 - CEILING AIRSPACE, E5 - ACOUSTIC

90 TILE).

91 ROOF1 = (E2 - 1/2 IN SLAG CR STONE, E3 - 3/8 IN FELT AND MEMBRANE,

92 INSULATION - RCOF FIBERBOARD 1/2 IN, INSULATION - EXPANDED EXT

93 POLYSTYRENE 5 IN, A3 - STEEL SIDING).

94 ROOF2 = (E2 - 1/2 IN SLAG CR STONE, E3 - 3/8 IN FELT AND MEMBRANE,

95 INSULATION - RCOF FIBERBOARD 1/2 IN, INSULATION - EXPANDED EXT

96 POLYSTYRENE 5 IN, A3 - STEEL SIDING, E4 - CEILING AIRSPACE, E5 -

97 ACOUSTIC TILE).

98 ROOF3 = (CONCRETE HW 3 IN, INSULATION - EXPANDED EXT POLYSTYRENE 3 IN,

99 E4 - CEILING AIRSPACE, E5 - ACOUSTIC TILE):

100 ENCI

101 DEFINE FLOORS1

102 FLOOR1 = (E5 - ACOUSTIC TILE, E4 - CEILING AIRSPACE, CONCRETE PW 3 IN),

103 FLOOR2 = (CONCRETE HW 5 1/2 IN, DIRT 12 IN),

104 FLOOR3 = (DIRT 12 IN),

105 FLOOR4 = (CONCRETE HW 3 IN):

106 ENCI

107 DEFINE WINDOWS1

108 GREEN TRIPLE PANE WINDOWS = (GLASS - GREEN SHEET 1/4 IN, B1 - AIRSPACE

109 RESISTANCE, GLASS - CLEAR PLATE 1/4 IN, B.1 - AIRSPACE RESISTANCE,

110 GLASS - CLEAR PLATE 1/4 IN).

111 KALBALL WINDOWS = (GLASS - KALWALL 2 3/4 IN),

112 GLASS CORR = (GLASS - GREEN SHEET 1/4 IN, B1 - AIRSPACE RESISTANCE,

US ARMY CORPS OF ENGINEERS -- BLAST VERSION 3.0 LEVEL 144			10 JUN 87	15.21.45.	PAGE 7
169	ENC SCHEDULE1				
170	DEFINE SCHEDULE NEW WEST INFIL11				
171	MONDAY THRU FRIDAY = (16 TO 06-0.375..5.1..5..375..375..5.5..5.375..5.5.				
172	1..5.5.1)				
173	SATURDAY THRU SUNDAY = 108 TO 24-0.3751				
174	SPECIAL1 = (16 TO 06-0.375..5.1..5..375..375..5.1..5..375..5.5..5.5.5.5.5.1).				
175	HOLIDAY = SUNDAY:				
176	ENC SCHEDULE2				
177	DEFINE SCHEDULE (FRONT WEST INFIL11				
178	MONDAY THRU FRIDAY = (16 TO 06-0.2.08 TO 18-1.01).				
179	SATURDAY THRU SUNDAY = 108 TO 24-0.21.				
180	SPECIAL1 = (12 TO 06-0.2.08 TO 18-1.01).				
181	HOLIDAY = SUNDAY:				
182	ENC SCHEDULE3				
183	..				
184	.. LIBRARY MODIFICATIONS - CONTROL DEFINITIONS				
185	..				
186	DEFINE CONTROLS (WEST STAT11				
187	PROFILES:				
188	HEAT = 15.1 AT 21.0.0 AT 221:				
189	SCHEDULES:				
190	MONDAY THRU SUNDAY = (00 TO 24-HEAT1:				
191	HOLIDAY = SUNDAY:				
192	ENC CONTROLS:				
193	DEFINE CONTROLS (WINTER STAT 11:				
194	PROFILES:				
195	HEATANCPRECOOL = (1.0 AT 20.9.0.0 AT 22.95.-1.0 AT 231:				
196	SCHEDULES:				

217 MONDAY THRU SUNDAY = 100 TO 24-HEATANDFREECOOL11

218 HOLIDAY = SUNDAY:

219 ENG CONTROLS:

220 DEFINE CONTROLS (WINTER STAT 211

221 PROFILES:

222 HEAT2 = 11.0 AT 20.9,0.0 AT 22.011

223 SCHEDULES:

224 MONDAY THRU SUNDAY = 100 TO 24-HEAT211

225 HOLIDAY = SUNDAY:

226 ENG CONTROLS:

227 **

228 ** PROJECT DESCRIPTION BLOCK

229 **

230 PROJECT = "JAS781 SMITH CARTER PARTNERS HEAT OFFICE BUILDING EVALUATION":

231 LOCATION = WINNIPEG:

232 GROUND TEMPERATURES = 11.9,11.5,11.5,11.9,12.0,13.3,

233 16.0,16.4,16.6,16.0,13.3,12.611

234 WEATHER TAPE FROM 21 DEC THRU 26 DEC:

235 **

236 ** BUILDING DESCRIPTION BLOCK

237 **

238 BEGIN BUILDING DESCRIPTION:

239 BUILDING = "SMITH CARTER PARTNERS HEAD OFFICE":

240 **

241 ** BUILDING CRISM AT STRUCTURAL COLUMN F1 AND TOP SURFACE OF LOWER

242 ** LEVEL PILL CAPS

243 **

244 DIMENSIONS:

253 INTERZONE FLOOR:

254 STARTING AT (8.11,227.8) FACING (S) FLOOR (30.282 BY 11.227)

255 ADJACENT TO ZONE (181)

256 PARTITIONS:

257 STARTING AT (1.27,8.8) FACING (S) PARTITION2 (5.166 BY NS)

258 STARTING AT (31.839,8.8) FACING (S) PARTITION2 (5.166 BY NS):

259 ** INFILTRATION RATE IS 0.75 ACH

260 INFILTRATION = 0.150, CONSTANT WITH COEFFICIENTS (1.8,8.8)

261 LIGHTS = 10.00, GEN OFFICE LIGHT:

262 LIGHTS = 6.48, CONSTANT:

263 ELECTRIC EQUIPMENT = 0.8, OFFICE OCCUPANCY:

264 PEOPLE = 25, OFFICE OCCUPANCY, AT ACTIVITY LEVEL 0.131

265 CONTROLS = WINTER STAT 1.37,7 HEATING,14.1 COOLING, FROM 16 SEP THRU 14 MAY:

266 ENG ZONE:

267 **

268 **

269 ZONE 2 - WEST VESTIBULE - 1

270 CRIGENT (0.905,10.973,H2):

271 EXTENSION HALLS:

272 STARTING AT (8.13,868.0) FACING (M) EXTERNA 1 (12.068 BY NS)

273 WITH WING (M) BY 1.27) AT (0.8)

274 WITH WING (M) BY 1.27) AT (3.048,0)

275 WITH OVERHANG (13.868 BY 1.27) AT (8.2,263)

276 WITH WINDOWS OF TYPE GREEN TRIPLE PANE WINDOWS

277 (0.480 BY 2.848) AT (0.8,152)

278 WITH WINDOWS OF TYPE GREEN TRIPLE PANE WINDOWS

279 (1.378 BY 2.848) AT (1.965,8.152)

280 WITH WINDOWS OF TYPE GREEN TRIPLE PANE WINDOWS

201 (2.035 BY 0.079) AT (0.2,230)

202 -- WITH WINDOWS OF TYPE SIDE ENTRANCE FRAME

203 -- (BY) AT (,)

204 WITH WINDOWS OF TYPE GLASS DOOR

205 10.745 BY 3.0231 AT (0.008,0.1521)

206 ROOF:

207 STARTING AT (0.3,040,M1) FACING (N) RCOF2 (3.040 BY 3.144):

208 FLOOR:

209 STARTING AT (5.144,0. (34,0) FACING (N) FLOOR1 (5.144 BY 2.214):

200 PARTITIONS:

201 STARTING AT (5.144,3.040,0) FACING (N) PARTITION2 (5.144 BY M5):

202 STARTING AT (9.144,0.0) FACING (E) PARTITION2 (3.040 BY M5):

203 STARTING AT (0.0,0) FACING (S) PARTITION2 (5.144 BY M5):

204 -- BEAK INFILTRATION RATE IS 2.0 ACH

205 INFILTRATION = 0.035, EM VEST INFIL. WITH COEFFICIENTS (1.0,0.0):

206 LIGHTS = 0.16, CONSTANT:

207 LIGHTS = 0.0, PHOTOCELL, 10 PERCENT VISIBLE, 80 PERCENT RADIANT:

208 CONTROLS = VEST STAT, 6.0 HEATING, FROM 16 SEP THRU 14 MAY:

209 ENC ZONE:

200 --

201 --

202 ZONE 3 "WALL-ROOF TWO-STORY ATRIUM":

203 -- ORIGIN AT SW CORNER OF SKYLIGHT SYSTEM WALL CENTERLINES AND

204 -- BASEMENT CONCRETE FLOOR CENTERLINE

205 ORIGIN: (7.231,10.590,M71):

206 EXTERIOR WALLS:

207 STARTING AT (0.0,7.201) FACING (S) TILTED (30) EXTERNALLY

208 (22.044 BY 2.152)

389 ** WITH WINDOWS OF TYPE SKYLIGHT MULLIONS

318 ** (BY 1 AT 1)

311 WITH WINDOWS OF TYPE KALWALL WINDOWS

312 (21.492 BY 1.913) AT (0.0),

313 STARTING AT (22.644,3.757,7.281) FACING (N) YLTER (N)1 EXTMALL

314 (22.644 BY 2.192)

315 ** WITH WINDOWS OF TYPE SKYLIGHT MULLIONS

316 ** (BY 1 AT 1)

317 WITH WINDOWS OF TYPE KALWALL WINDOWS

318 (21.492 BY 1.913) AT (0.0),

319 STARTING AT (0.0,0.6,756) FACING (S) EXTMALL (22.644 BY 0.445),

320 STARTING AT (22.644,3.757,6.756) FACING (N) EXTMALL (22.644 BY 0.445),

321 STARTING AT (0.3,797,6.756) FACING (N) EXTMALL (3.797 BY 0.993),

322 STARTING AT (22.644,0.6,756) FACING (E) EXTMALL (3.797 BY 0.993),

323 ECOFI

324 STARTING AT (0.0,0.6,756) FACING (E) ROOF1 (3.040 BY 2.046),

325 SLAB ON GRADE FLOOR

326 STARTING AT (0.3,531,0) FACING (S) FLOOR2 (22.149 BY 3.531),

327 INTERZONE PARTITIONS

328 STARTING AT (22.149,3.531,0) FACING (N) EXTMALL (22.149 BY 3.531)

329 ADJACENT TO ZONE (10);

330 PARTITIONS

331 STARTING AT (0.3,531,0) FACING (N) PARTITION2 (3.531 BY 3.531),

332 STARTING AT (22.149,0.6,756) FACING (E) PARTITION2 (3.531 BY 3.531),

333 STARTING AT (0.3,531,0) FACING (N) PARTITION1 (3.531 BY 3.531),

334 STARTING AT (22.149,0.6,756) FACING (E) PARTITION1 (3.531 BY 3.531),

335 ** INFILTRATION RATE IS 0.75 ACH

336 INFILTRATION = 0.187, CONSTANT, WITH COEFFICIENTS (1.0,0.0),

337 MIXING = 0.274, FROM ZONE 13;

338 MIXING = 0.456, FROM ZONE 11

339 MIXING = 0.589, FROM ZONE 6;

340 MIXING = 0.139, FROM ZONE 7;

341 MIXING = 0.168, FROM ZONE 8;

342 LIGHTS = 0.31, OFFICE OCCUPANCY;

343 LIGHTS = 4.2, OFF, 10 PERCENT VISIBLE, 80 PERCENT RADIANT;

344 LIGHTS = 0.45, CONSTANT, 10 PERCENT VISIBLE, 80 PERCENT RADIANT;

345 PEOPLE = 20, ATRIUM OCCUPANCY, AT ACTIVITY LEVEL 0.13;

346 CONTROLS = WINTER STAF 2, 10.3 HEATING, FROM 16 SEP THRU 14 MAY;

347 ** INTERNAL PASS OF THIS ZONE IS IGNORED

348 ENC ZONE:

349 **

350 **

351 ZONE 4 "EAST VESTIBULE":

352 ORIGIN: (11.545,10.973,MC);

353 EXTERIOR WALLS:

354 STARTING AT (5.144,0.0) FACING (E) EXTNAL-1 (3.040 BY H1)

355 WITH WING (H1 BY 1.27) AT (0.0)

356 WITH WING (H1 BY 1.27) AT (11.148,0)

357 WITH OVERHANG (3.040 BY 1.27) AT (0.2,743)

358 WITH WINDOWS OF TYPE GREEN TRIPLE PANE WINDOWS

359 (1.378 BY 2.288) AT (0.0,1.52)

360 WITH WINDOWS OF TYPE GREEN TRIPLE PANE WINDOWS

361 (0.400 BY 2.040) AT (2.543,0.152)

362 WITH WINDOWS OF TYPE GREEN TRIPLE PANE WINDOWS

363 (2.615 BY 0.475) AT (0.2,200)

364 ** WITH WINDOWS OF TYPE SICE ENTRANCE FRAME

365 ** (0V) AT (0)

366 WIP WINDOWS OF TYPE GLASS DOOR

367 (0.765 BY 1.073) AT (1.578,0.152) I

368 ROOF

369 STARTING AT (0.0,0.0) FACING (S) ROOF (S) 10.0 BY 1.0

370 FLOOR

371 STARTING AT (5.144,0.134,0) FACING (N) FLOOR (S) 10.0 BY 2.214 I

372 PARTITIONS

373 STARTING AT (0.0,0) FACING (S) PARTITION2 (S) 10.0 BY 10.0

374 STARTING AT (0.0,0.0) FACING (N) PARTITION2 (S) 10.0 BY 10.0

375 STARTING AT (5.144,1.048,0) FACING (N) PARTITION2 (S) 10.0 BY 10.0

376 ** PEAK INFILTRATION RATE IS 2.0 ACH

377 INFILTRATION = 0.035-EM VEST INFIL WITH COEFFICIENTS (1.0,0.0) I

378 LIGHTS = 0.0, CONSTANT

379 LIGHTS = 0.0, PHOTOCELL, 10 PERCENT VISIBLE, 0.0 PERCENT RADIANT I

380 CONTROLS = VEST STAT, 0.0 HEATING, FROM 16 SEP THRU 14 MAY

381 ENC ZONE

382 **

383 **

384 ZONE 5 - ACCOUNTING DEVICES I

385 CRIGM (0.254,0.254,0.254,0.254) I

386 EXTERIOR WALLS

387 STARTING AT (0.0,0) FACING (S) EXTERIOR WALL (S) 10.0 BY 10.0

388 STARTING AT (0.0,1.027,0) FACING (N) EXTERIOR WALL (S) 10.0 BY 10.0

389 STARTING AT (1.027,1.027,0) FACING (N) EXTERIOR WALL (S) 10.0 BY 10.0

390 ROOF

391 STARTING AT (0.0,0) FACING (S) ROOF (S) 10.0 BY 1.0

392 FLOOR

393	STARTING AT (0.11.227.0) FACING (S) FLOOR (3.366 BY 11.227);
394	PARTITIONS;
395	STARTING AT (3.366.11.227.0) FACING (N) PARTITION2 (2.147 BY M5);
396	STARTING AT (3.366.0.0) FACING (E) PARTITION1 (7.311 BY M6);
397	STARTING AT (1.166.2.311.0) FACING (E) PARTITION29 (1.314 BY M4);
398	INTERNAL PASS;
399	PARTITION1 (14.173 BY M6);
400	SP. IMBILITATION RATE IS 0.5 ACH
401	IMFILTRATION = 0.019, CONSTANT, WITH COEFFICIENTS (1.0.0.0);
402	LIGHTS = 1.12. G2M OFFICE LIGHT;
403	ELECTRIC EQUIPMENT = 0.90. DEVICE OCCUPANCY;
404	PEOPLE = 4. OFFICE OCCUPANCY, AT ACTIVITY LEVEL 0.13;
405	CONTROLS = WINTER STAT 2. 2.4 HEATING, FROM 16 SEP THRU 14 MAY;
406	ENC. ZONE;
407	**
408	**
409	ZONE 6 - "CONSULTED, SECRETARY AND MEETING ROOMS"-1
410	CRIGING (3.312.4.636.M6);
411	ROOF;
412	STARTING AT (0.0.0.0) FACING (S) ROOF2 (19.482 BY F.457);
413	FLOOR;
414	STARTING AT (0.6.757.0) FACING (S) FLOOR1 (19.402 BY 6.757);
415	PARTITIONS;
416	STARTING AT (0.0.0) FACING (S) PARTITION1 (17.761 BY M6);
417	STARTING AT (0.6.337.0) FACING (N) PARTITION1 (3.479 BY M6);
418	STARTING AT (0.2.859.0) FACING (N) PARTITION29 (2.859 BY M4);
419	STARTING AT (2.997.0.337.0) FACING (N) PARTITION2 (2.997 BY M6);
420	STARTING AT (19.402.-2.996.0) FACING (E) PARTITION1 (7.493 BY M6);

421 EXTERIOR WALLS:

422 STARTING AT (18.27,-2.597,0) FACING (5) EXTERNAL (1,2,4,5 BY M3)

423 ** WITH WINDOWS OF TYPE MAIN ENTRANCE FRAME

424 ** (9') AT (0')

425 WITH WINDOWS OF TYPE GREEN TRIPLE PANE WINDOWS

426 (0.948 BY 2.591) AT (0.0,152):

427 INTERNAL PASS:

428 PARTITION2 (22.06 BY M61):

429 INTERNAL PASS:

430 PARTITION1 (62.09 BY M61):

431 INTERNAL PASS:

432 PARTITION99 (5.486 BY 1.908):

433 ** INFILTRATION RATE IS 0.5 ACM

434 IMEILTRATION = 0.065, CONSTANT, WITH COEFFICIENTS (1,8,8,0):

435 MIXING = 0.683, FROM ZONE 5:

436 MIXING = 0.364, FROM ZONE 9:

437 LIGHTS = 0.00, CONSTANT:

438 LIGHTS = 1.00, GEN OFFICE LIGHT:

439 LIGHTS = 0.16, CONFERENCE ROOM LIGHT:

440 LIGHTS = 1.3, GEN OFFICE LIGHT, 10 PERCENT VISIBLE, 10 PERCENT RADIANT:

441 LIGHTS = 0.3, CONSTANT, 10 PERCENT VISIBLE, 10 PERCENT RADIANT:

442 LIGHTS = 0.24, OFF:

443 ELECTRIC EQUIPMENT = 0.66, OFFICE OCCUPANCY:

444 ELECTRIC EQUIPMENT = 0.75, CONSTANT: ** PINICOMPUTER

445 PEOPLE = 4, OFFICE OCCUPANCY, AT ACTIVITY LEVEL 0.13:

446 CONTROLS = WINTER STAT 2, 5.8 HEATING, FROM 1.6 SEP THRU 1.6 MAY:

447 ENG ZONE:

448 **

449	00	
450	00	ZONE 7 - RECEPTION AREA - 1
451	00	CRIGING (22.593, 1.638, 1.461) :
452	00	EXTERIOR WALLS:
453	00	STARTING AT (0.0, 0.0) FACING (S) EXTERNAL (11.499 BY M3)
454	00	WITH WINDOWS OF TYPE GREEN TRIPLE PANE WINCONS
455	00	(1.422 BY 2.591) AT (0.0, 1.521).
456	00	WITH WINDOWS OF TYPE MAIN ENTRANCE FRASE
457	00	(3V) AT (0.0)
458	00	STARTING AT (5.994, 0.0) FACING (S) EXTERNAL (11.499 BY M3)
459	00	WITH WINDOWS OF TYPE GREEN TRIPLE PANE WINCONS
460	00	(1.422 BY 2.591) AT (0.0, 1.521) :
461	00	WITH WINDOWS OF TYPE MAIN ENTRANCE FRASE
462	00	(3V) AT (0.0)
463	00	FLOOR:
464	00	STARTING AT (0.0, 0.0) FACING (S) FLOOR (7.493 BY 8.436) :
465	00	PARTITIONS:
466	00	STARTING AT (0.0, 0.0) FACING (S) FLOOR (7.493 BY 8.436) :
467	00	PARTITIONS:
468	00	STARTING AT (0.0, 0.0) FACING (S) FLOOR (7.493 BY 8.436) :
469	00	STARTING AT (7.493, 0.0) FACING (E) PARTITION (7.493 BY M3) :
470	00	STARTING AT (1.499, 0.0) FACING (E) PARTITION (1.499 BY M3) :
471	00	STARTING AT (1.499, 0.0) FACING (S) PARTITION (1.499 BY M3) :
472	00	INFILTRATION RATE IS 0.75 ACH
473	00	INFILTRATION = 0.045, CONSTANT, WITH COEFFICIENTS (1.0, 0.0) :
474	00	LIGHTS = 0.04, GEN OFFICE LIGHTS:
475	00	LIGHTS = 0.04, CONSTANT:
476	00	LIGHTS = 1.0, OFF, 10 PERCENT VISIBLE, 80 PERCENT NAUGHT:

677 ELECTRIC EQUIPMENT = 0.2, OFFICE OCCUPANCY;

678 PEOPLE = 1, OFFICE OCCUPANCY, AT ACTIVITY LEVEL 8.131

679 CONTROLS = WINTER STAY 2, 4.8 HEATING, FROM 16 SEP 1980 14 MAY;

680 ** INTERNAL PASS OF THIS ZONE (INCLUDING KALWAL) IS IGNORED

681 EMP ZONE1

682 **

683 **

684 ZONE A "CONFERENCE ROOM"

685 ORIGIN (31.331,-0.250,M4);

686 EXTERIOR WALLS

687 STARTING AT (0.0,0) FACING (S) EXTERNAL (1.507 BY M1)

688 STARTING AT (0.617,0.0) FACING (E) EXTERNAL 1 (1.117 BY M3);

689 STARTING AT (0.1,0.02,0) FACING (M) EXTERNAL 1 (1.037 BY M3);

690 STARTING AT (0.617,1.1,227.0) FACING (M) EXTERNAL 1 (1.166 BY M1)

691 STARTING AT (-1.245,1.092,0) FACING (S) EXTERNAL 1 (1.245 BY M3)

692 ** WITH WINDOWS OF TYPE MAIN ENTRANCE FRAME

693 ** (BY 1 AT 1)

694 WITH WINDOWS OF TYPE GREEN TRIPLE PANE WINDOWS

695 (0.940 BY 2.591) AT (0.0,152);

696 PARTITIONS:

697 STARTING AT (-1.245,9.385,0) FACING (M) PARTITION1 (7.493 BY M6);

698 STARTING AT (5.390,11.227,0) FACING (M) PARTITION2 (5.144 BY M5);

699 ROOF:

500 STARTING AT (-1.245,0,M3) FACING (S) SCOF2 (7.062 BY 10.926);

501 FLOOR:

502 STARTING AT (-1.245,16.927,0) FACING (S) FLOOR1 (7.062 BY 10.927);

503 INTERNAL PASS:

504 PARTITION1 (40.094 BY M6);

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505 ** INFILTRATION RATE IS 3.5 ACH

506 IMEILTRATION = 0.062.CONSTANT.WITH COEFFICIENTS (1.0,0.0,1)

507 LIGHTS = 0.92. CONFERENCE ROOM LIGHT:

508 LIGHTS = 2.4. CONFERENCE ROOM LIGHT, 10 PERCENT VISIBLE, 00 PERCENT

509 BACTANT:

510 ELECTRIC EQUIPMENT = 0.1. CONSTANT:

511 PEOPLE = 6. CONFERENCE OCCUPANCY, AT ACTIVITY LEVEL 0.13:

512 CONTROLS = WINTER STAT 2.0.0.0 HEATING. EACH 1.6 SEP THRU 1.6 MAY:

513 END ZONE:

514 **

515 **

516 ZONE 9 "SUNLIT CORRIDOR AND PARTNERS OFFICES":

517 CRIGIN: (3.112,-0.25%,N%):

518 EXTERIOR WALLS:

519 STARTING AT (0.0,0) FACING (S) EXTMALLS (16.182 BY H3)

520 WITH WINDOWS OF TYPE GREEN TRIPLE PANE WINDOWS

521 (1.016 BY 2.628) AT (2.0,0.152) AND (16.16,0.152)

522 ** WITH WINDOWS OF TYPE SOUTH WALL HULLIONS

523 ** (2Y) AT (0)

524 WITH WINDOWS OF TYPE KALWALL WINDOWS

525 (12.744 BY 2.654) AT (1.016,0.152).

526 STARTING AT (10.237,0.0) FACING (E) EXTMALLS (1.037 BY H3):

527 ECOFI

528 STARTING AT (0.0,M3) FACING (S) RCOF2 (10.237 BY 4.646):

529 FLOOR:

530 STARTING AT (18.0,0.0) FACING (S) FLOOR1 (10.237 BY 4.646):

531 PARTITIONS:

532 STARTING AT (17.701,4.090,0) FACING (N) PARTITION1 (16.020 BY M6):

533 STARTING AT (0.953,4.890,0) FACING (M) PARTITION99 (8.953 BY M6);

534 STARTING AT (8.4,898,0) FACING (M) PARTITION99 (2.879 BY M6);

535 STARTING AT (0.2,811,0) FACING (M) PARTITION99 (2.011 BY M6);

536 INTERNAL PASS1

537 PARTITION99 (12.885 BY M6);

538 INTERNAL PASS1

539 PARTITION99 (17.374 BY 1.505);

540 ** INFILTRATION RATE IS 0.75 ACH

541 INFILTRATION = 0.863, CONSTANT, WITH COEFFICIENTS (1.0,6.0);

542 MIXING = 0.142, FROM ZONE 6;

543 LIGHTS = 0.75, OFF, 10 PERCENT VISIBLE, 80 PERCENT RADIANT;

544 LIGHTS = 0.66, GEN OFFICE LIGHT;

545 LIGHTS = 0.6, GEN OFFICE LIGHT, 10 PERCENT VISIBLE, 80 PERCENT RADIANT;

546 LIGHTS = 0.32, OFF;

547 LIGHTS = 0.30, OFF, 10 PERCENT VISIBLE, 80 PERCENT RADIANT;

548 PEOPLE = 2, OFFICE OCCUPANCY, AT ACTIVITY LEVEL 0.13;

549 CONTROLS = NINETEEN STAT 2, 6.6 HEATING, FECK 16 SEP THRU 14 MAY;

550 END ZONE;

551 **

552 **

553 ZONE 10 "CRAWL SPACE"

554 ORIGIN: (-0.152,14.249,M7);

555 EXTERIOR WALLS;

556 STARTING AT (0.10,897,M8) FACING (M) EXTERNALS (10.897 BY M12);

557 STARTING AT (37.990,10.897,M8) FACING (M) EXTERNALS (37.990 BY M12);

558 STARTING AT (37.990,0,M8) FACING (M) EXTERNALS (10.897 BY M12);

559 INTERZONE CEILING;

560 STARTING AT (0.0,M13) FACING (S) CEILING1 (30.202 BY 11.227)

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561	ADJACENT TO ZONE (11)			
562	SLAB ON GRADE FLOOR			
563	** USE EQUIVALENT FLOOR AREA OF APPROX. 4710 FT ²			
564	STARTING AT (0.11,510.0) FACING (S) FLOOR (37.998 BY 11.510)			
565	INTERZONE PARTITIONS			
566	STARTING AT (0.0,0) FACING (S) EXTHALL 0 (7.925 BY M13)			
567	ADJACENT TO ZONE (11)			
568	STARTING AT (7.925,0.0) FACING (S) EXTHALL 1 (22.148 BY M13)			
569	ADJACENT TO ZONE (11)			
570	STARTING AT (10.073,0.0) FACING (S) EXTHALL 0 (6.62 BY M13)			
571	ADJACENT TO ZONE (11)			
572	** INFILTRATION RATE IS 0.5 ACH			
573	INFILTRATION = 0.018, CONSTANT, WITH COEFFICIENTS (1.0,0.0)			
574	WINDING = 2.402, FROM ZONE 11			
575	LIGHTS = 1.5, OFF, 10 PERCENT VISIBLE, 80 PERCENT RADIANT			
576	LNC ZONE			
577	**			
578	**			
579	ZONE 11 "ELECTRICAL AND MECHANICAL ROOMS"			
580	CRIGINI (0.132,0.132,M7)			
581	EXTERIOR WALLS			
582	STARTING AT (0.0,M3) FACING (S) EXTHALL 2 (5.893 BY M9)			
583	STARTING AT (0.14,402.0) FACING (M) EXTHALL 2 (14.402 BY 0.901)			
584	STARTING AT (1.219,11.049,2.067) FACING (M) EXTHALL 2 (1.219 BY 0.457)			
585	BASEMENT WALLS			
586	STARTING AT (0.0,0) FACING (S) EXTHALL 2 (1.403 BY M1).			
587	STARTING AT (0.14,402.0) FACING (M) EXTHALL 2 (14.402 BY M9)			
588	SLAB ON GRADE FLOOR			

589 STARTING AT (0.14,402,0) FACING (S) FLOOR (6.187 BY 14.402) :

590 ROOF :

591 STARTING AT (0.14,173,113) FACING (W) ROOF (3.048 BY 1.219) :

592 INTERZONE PARTITIONS :

593 STARTING AT (7.925,144,12.01) FACING (W) EXTERIOR (7.925 BY 11.11) :

594 ADJACENT TO ZONE (10) :

595 CEILING :

596 STARTING AT (10.0,111) FACING (S) CEILING (5.952 BY 14.402) :

597 PARTITIONS :

598 STARTING AT (5.093,0,0) FACING (E) PARTITION (6.505 BY 11.4) :

599 STARTING AT (5.093,0,545.61) FACING (E) PARTITION (6.401 BY 11.11) :

600 INTERNAL PASS :

601 PARTITION (14.326 BY 14) :

602 INTERNAL PASS :

603 PARTITION (14.48 BY 11.11) :

604 ** INFILTRATION RATE IS 0.5 ACH

605 INFILTRATION = 0.019, CONSTANT, WITH COEFFICIENTS (1,0,0,0) :

606 MIXING = 0.274, FROM ZONE 13 :

607 MIXING = 0.402, FROM ZONE 10 :

608 LIGHTS = 0.15, OFF, 10 PERCENT VISIBLE, 00 PERCENT RADIANT :

609 LIGHTS = 0.44, OFF :

610 ELECTRIC EQUIPMENT = 0.3, CONSTANT :

611 ** INTERNAL PASS OF STAIRS IS IGNORED

612 ENC ZONE :

613 **

614 **

615 ZONE 12 "BASEMENT PERIMETER ROOMS" :

616 CRIGIN (5.740,0,152.47) :

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617	EXTENSION WALLS:			
618	STARTING AT (0.0,0.0) FACING (S) EXTMALL2 (12.162 BY M1).			
619	STARTING AT (32.105,0.0) FACING (E) EXTMALL2 (14.402 BY 0.961).			
620	STARTING AT (32.105,11.049,2.667) FACING (M) EXTMALL2 (1.219 BY 0.457).			
621	BASEMENT WALLS:			
622	STARTING AT (0.0,0.0) FACING (S) EXTMALL2 (32.105 BY M1).			
623	STARTING AT (32.105,0.0) FACING (E) EXTMALL2 (14.402 BY M1).			
624	STARTING AT (32.105,14.402,0) FACING (M) EXTMALL2 (1.219 BY M1).			
625	INTERZONE PARTITIONS:			
626	STARTING AT (30.800,14.402,0) FACING (M) EXTMALL2 (6.62 BY M1).			
627	ADJACENT TO ZONE (1.0):			
628	ROOFS:			
629	STARTING AT (32.106,14.173,M13) FACING (M) ROOF3 (1.219 BY 3.048).			
630	STARTING AT (15.603,0,M11) FACING (S) ROOF3 (9.982 BY 1.780).			
631	SLAB ON GRADE FLOORS:			
632	STARTING AT (0.4,471.0) FACING (S) FLOOR2 (32.105 BY 1.471).			
633	STARTING AT (32.105,471.0) FACING (M) FLOOR2 (6.366 BY 9.931).			
634	CEILING:			
635	STARTING AT (0.0,M11) FACING (S) CEILING2 (32.105 BY 3.773).			
636	PARTITIONS:			
637	STARTING AT (32.105,471.0) FACING (M) PARTITION1 (31.030 BY M14).			
638	STARTING AT (26.101,14.402,0) FACING (M) PARTITION1 (5.500 BY M15).			
639	STARTING AT (12.442,0) FACING (M) PARTITION1 (6.471 BY M14).			
640	INTERNAL PASS:			
641	PARTITION1 (99.400 BY M14):			
642	INTERNAL PASS:			
643	PARTITION1 (14.403 BY M15):			
644	** INFILTRATION RATE IS 3.5 ACH			

645 INFILTRATION = 0.044, CONSTANT, WITH COEFFICIENTS (1.0, 0.0, 0.0)

646 LIGHTS = 1.58, GEN OFFICE LIGHT

647 LIGHTS = 0.9, GEN OFFICE LIGHT, 10 PERCENT VISIBLE, 80 PERCENT RADIANT

648 LIGHTS = 0.32, OFF

649 LIGHTS = 0.1, OFF, 10 PERCENT VISIBLE, 80 PERCENT RADIANT

650 ELECTRIC EQUIPMENT = 4.0, GEN OFFICE LIGHT, 5 PERCENT RADIANT

651 80 PERCENT LOST

** PRINT MACHINE W/EXHAUST

652 ELECTRIC EQUIPMENT = 0.58, GEN OFFICE LIGHT

653 PEOPLE = 3, OFFICE OCCUPANCY, AT ACTIVITY LEVEL 0.13

654 CONTROLS = WINTER STAT 2, 6-8 HEATING, FROM 16 SEP THRU 14 MAY

655 END ZONE

656 **

657 **

658 ZONE 11 - BASEMENT CENTER

659 CRICING (5.740, 4.318, 0.071)

660 SLAB ON GRADE FLOOR

661 STARTING AT (0.0, 0.0) FACING (S) FLOOR 2 (16.161 BY 6.622)

662 CEILING

663 STARTING AT (0.0, 0.0) FACING (S) CEILING 2 (26.161 BY 7.031)

664 PARTITIONS

665 STARTING AT (0.0, 0.0) FACING (S) PARTITION 1 (31.036 BY 11.4)

666 STARTING AT (0.0, 0.0) FACING (W) PARTITION 1 (4.115 BY 11.4)

667 STARTING AT (26.162, 0.0) FACING (E) PARTITION 1 (6.706 BY 11.4)

668 INTERNAL PASS

669 PARTITION 1 (61.585 BY 11.4)

670 INTERNAL PASS

671 PARTITION 1 (35.916 BY 11.4)

672 MIXING = 0.211, FROM ZONE 12

673 LIGHTS = 0.2. CONSTANT. 10 PERCENT VISIBLE. 10 PERCENT RADIANT:

674 LIGHTS = 2.875. OCCASIONAL. 10 PERCENT VISIBLE. 10 PERCENT RADIANT:

675 LIGHTS = 1.7. OFF:

676 LIGHTS = 0.4. CONSTANT:

677 ELECTRIC EQUIPMENT = 3.5. GEN OFFICE LIGHT:

678 PEOPLE = 6. BASEMENT CENTER OCCUPANCY. AT ACTIVITY LEVEL 0.13:

679 CONTROLS = WINTER STAT 2. 9.0 HEATING. FROM 16 SEP THRU 14 MAY:

680 END ZONE:

681 **

682 **

683 ZONE 14 - EXCH VESTIBULE=1

684 CRIGEM (24.092,1.636,M6):

685 EXTERIOR WALLS:

686 STARTING AT (0.0,0) FACING (1) EXTERIOR (1.496 BY 1.496)

687 WITH WINDOWS OF TYPE GREEN TRIPLE PANE WINDOWS

688 (1.651 BY 2.591) AT (0.0,1.52)

689 AND (2.845,0.152)

690 WITH WINDOWS OF TYPE GREEN TRIPLE PANE WINDOWS

691 (0.066 BY 0.554) AT (1.815,1.000)

692 WITH WINDOWS OF TYPE MATH ENTRANCE FRAME

693 ** (BY) AT (,)

694 WITH WINDOWS OF TYPE GLASS DOOR

695 (0.711 BY 1.000) AT (1.815,0.152):

696 ROOF:

697 STARTING AT (0.0,0) FACING (1) ROOF2 (4.496 BY 1.496):

698 FLOORS:

699 STARTING AT (0.1,499.0) FACING (1) FLOOR1 (4.496 BY 1.496):

700 PARTITIONS:

781 STARTING AT (8.1.499.0) FACING (N) PARTITION99 (1.499 BY M6).

782 STARTING AT (1.4.596.8.8) FACING (E) PARTITION99 (1.499 BY M6).

783 ** INTERNAL PASS OF VALHALL WALL IGNORED

784 ** PEAK INFILTRATION RATE IS 5.8 ACH

785 INFILTRATION = 8.833 FRONT WEST INFIL WITH COEFFICIENTS (1.8.8.8).

786 LIGHTS = 8.8. PHOTOCELL. 10 PERCENT VISIBLE. 80 PERCENT RADIANT:

787 CONTROLS = VEST STAT. 6.0 HEATING. FROM 16 SEP THRU 14 MAY:

788 ENC ZONE:

789 **

790 ENC BUILDING DESCRIPTION:

791 ENC INPUT: